OREGON WILD

14 August 2019

TO: Ashley Popham, Barlow District Planner
VIA: comments-pacificnorthwest-mthood-barlow@fs.fed.us

Subject: Grasshopper Project — scoping comments

Please accept the following scoping comments from Oregon Wild concerning the Grasshopper Project, https://www.fs.usda.gov/project/?project=56470. Oregon Wild represents 20,000 members and supporters who share our mission to protect and restore Oregon's wildlands, wildlife, and water as an enduring legacy. Our goal is to protect areas that remain intact while striving to restore areas that have been degraded. This can be accomplished by moving over-represented ecosystem elements (such as logged and roaded areas) toward characteristics that are currently under-represented (such as roadless areas and complex old forest).

The proposed action alternative involves:

- 3903 acres of Variable Density Thinning (VDT) from Below in existing multi-cohort stands (mostly mature/unmanaged stands)
- 1398 acres Intermediate Sapling Thinning in Plantations < 40 years of age
- 357 acres Intermediate Commercial Thinning in Plantations 40-80 years of age
- 15-20 mmbf

Overview

Oregon Wild supports careful variable thinning of dense young stands in both Late Successional Reserve and matrix and the outer half of riparian reserves. We are very skeptical of the effectiveness of commercial logging as a restoration tool in mature, previously unmanaged forests. Wild and prescribed fire and non-commercial thinning can often achieve better restoration outcomes than commercial logging that requires heavy equipment, roads, soil damage, and removes vast amounts of valuable biomass that would otherwise contribute to soil health, water quality, carbon storage, and habitat for a wide variety of fish & wildlife.

Alternatives

We urge the Forest Service to consider an alternative that:

- avoids commercial logging and road building in inventoried and uninventoried roadless areas,
- avoids commercial logging and road building in riparian reserves and critical habitat stands over 80 years old,

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- applies a 20” dimeter limit on early seral species such as pine, oak, and Douglas-fir, and a 24” dbh limit on white fir/grand fir; and
- follows the forest plan. i.e., avoids any forest plan amendments or variances.

Effects Analysis

We urge the Forest Service to take a hard look at the effects of this project on:

- carbon and climate change and the social cost of carbon dioxide emissions. (Do not rely on the inaccurate and misleading boilerplate from the RO);
- optimal habitat for wildlife that prefer dense forest cover, including big game, marten, pileated woodpecker, goshawk, northern spotted owl, etc.;
- optimal habitat for wildlife that prefer abundant snags and down wood, such as spotted owl prey, woodpeckers, fish, etc. Please provide a future projection of future recruitment of large and small snags under the various alternatives and compare that to DecAID’s description of optimal snag requirements of key species;
- soil, water quality, and the spread of weeds;

Forest Plan Amendments

We oppose forest plan amendments that allow more logging. The forest plan is there for a reason and helps mitigate for the significant adverse effects of commercial logging. The Forest Service can achieve a large proportion of its restoration objectives without amending the forest plan.

The Purpose and Need should Address The Unmet Need for Carbon Storage

The agency says one of the purposes of this project is provide a supply of wood products to the public. The agency should reconsider timber targets in light of the fact that the public *needs* carbon storage to reduce global climate change much more than they *need* wood products. The agency must recognize that wood products are already under-priced and over-supplied due to “externalities” (costs that are not included in the price of wood, so they are shifted from wood product producers and consumers to the general public who suffer the consequences of climate change without compensation from those who profit from logging related GHG emissions). Ecosystem carbon storage on the other hand is under-supplied because there is not a functioning market for carbon storage and climate services. The FS is in a position to address these market imperfections by focusing on unmet demand for carbon storage instead of offering wood products that are already oversupplied.

> Land protection, both public and private, provides substantial ecological benefits by avoiding conversion of natural systems to intensive, developed uses. These benefits include carbon sequestration, watershed functioning, soil conservation, and the preservation of diverse habitat types (e.g., Daily 1997, Brauman et al. 2007, Kumar 2012, Watson et al. 2014). Land protection also solves a key market failure: private markets

> tend to underprovide socially beneficial land uses such as natural forests, agricultural lands, or managed timberlands. The reason for this failure is that many of the benefits of these lands go to the public in general, not individual landowners. When private values and market transactions determine land uses, less land will be devoted to socially beneficial uses than if citizens could collectively determine use on the basis of social values (e.g., Angelsen 2010, Tietenberg and Lewis 2016).

Katharine R.E. Sims, Jonathan R. Thompson, Spencer R. Meyer, Christoph Nolte, Joshua S. Plisinski. 2019. Assessing the local economic impacts of land protection. Conservation Biology. 26 March 2019 https://doi.org/10.1111/cobi.13318, https://harvardforest.fas.harvard.edu/sites/default/files/Sims_et_al-2019-Conservation_Biology.pdf.

Roadless/Unroaded

Large intact expanses of habitat were once quite common but are now rare. Species evolved in the context of the large habitat patches that result from the natural disturbance regime. As just one important example, big game need large patches of security cover which is best provided by large unroaded areas. New science confirms that roads and logging tend to be contagious on the landscape (managed areas beget more management until little remains unmanaged), so to conserve the habitat values associated with wild places we have to prevent the first intrusions. The purpose and need for this project should include protecting and restoring large unroaded areas consistent with the natural range of variability.

Boakes et al (2009) explained why it is important to retain large unroaded areas.

> **Abstract:** Habitat clearance remains the major cause of biodiversity loss, with consequences for ecosystem services and for people. In response to this, many global conservation schemes direct funds to regions with high rates of recent habitat destruction, though some also **emphasize the conservation of remaining large tracts of intact habitat**. If the pattern of **habitat clearance is highly contagious**, the latter approach will help **prevent destructive processes gaining a foothold** in areas of contiguous intact habitat. Here, we test the strength of spatial contagion in the pattern of habitat clearance. Using a global dataset of land-cover change at 50x50 km resolution, we discover that intact habitat areas in grid cells are refractory to clearance only when all neighbouring cells are also intact. The **likelihood of loss increases dramatically as soon as habitat is cleared in just one neighbouring cell**, and remains high thereafter. **This effect is consistent for forests and grassland, across biogeographic realms and over centuries, constituting a coherent global pattern**. Our results show that landscapes become vulnerable to wholesale clearance as soon as **threatening processes begin to penetrate**, so actions to prevent any incursions into large, intact blocks of natural habitat are key to their long-term persistence.

Elizabeth H. Boakes, Georgina M. Mace, Philip J. K. McGowan and Richard A. Fuller 2009. Extreme contagion in global habitat clearance. Proceedings of the Royal Society B: Biological Sciences. November 25, 2009. doi: 10.1098/rspb.2009.1771.
http://rspb.royalsocietypublishing.org/content/royprsb/early/2009/11/25/rspb.2009.1771.full.pdf

Ibisch et al (2016) said

> The planet's remaining large and ecologically important tracts of roadless areas sustain key refugia for biodiversity and provide globally relevant ecosystem services. … Global protection of ecologically valuable roadless areas is inadequate. International recognition and protection of roadless areas is urgently needed to halt their continued loss.
>
> …
>
> The impact of roads on the surrounding landscape extends far beyond the roads themselves. Direct and indirect environmental impacts include deforestation and fragmentation, chemical pollution, noise disturbance, increased wildlife mortality due to car collisions, changes in population gene flow, and facilitation of biological invasions (1–4). In addition, roads facilitate "contagious development," in that they provide access to previously remote areas, thus opening them up for more roads, land-use changes, associated resource extraction, and human-caused disturbances of biodiversity (3, 4). With the length of roads projected to increase by >60% globally from 2010 to 2050 (5), there is an urgent need for the development of a comprehensive global strategy for road development if continued biodiversity loss is to be abated (6). To help mitigate the detrimental effects of roads, their construction should be concentrated as much as possible in areas of relatively low "environmental values" (7). Likewise, prioritizing the protection of remaining roadless areas that are regarded as important for biodiversity and ecosystem functionality requires an assessment of their extent, distribution, and ecological quality.
>
> …
>
> There is an urgent need for a global strategy for the effective conservation, restoration, and monitoring of roadless areas and the ecosystems that they encompass. Governments should be encouraged to incorporate the protection of extensive roadless areas into relevant policies and other legal mechanisms, reexamine where road development conflicts with the protection of roadless areas, and avoid unnecessary and ecologically disastrous roads entirely. In addition, governments should consider road closure where doing so can promote the restoration of wildlife habitats and ecosystem functionality (4).
>
> …
>
> To achieve global biodiversity targets, policies must explicitly acknowledge the factors underlying prior failures (13). Despite increasing scientific evidence for the negative impacts of roads on ecosystems, the current global conservation policy framework has largely ignored road impacts and road expansion.
>
> …

> In the much wider context of the United Nations' Sustainable Development Goals, conflicting interests can be seen between goals intended to safeguard biodiversity and those promoting economic development (14).
>
> …
>
> Enshrined in the protection of roadless areas should be the objective to seek and develop alternative socioeconomic models that do not rely so heavily on road infrastructure. … Although we acknowledge that access to transportation is a fundamental element of human well-being, impacts of road infrastructure require a fully integrated environmental and social cost benefits approach (15). Still, under current conditions and policies, limiting road expansion into roadless areas may prove to be the most cost effective and straightforward way of achieving strategically important global biodiversity and sustainability goals.

Pierre L. Ibisch, Monika T. Hoffmann, Stefan Kreft, Guy Pe'er, Vassiliki Kati, Lisa Biber-Freudenberger, Dominick A. Dellasala, Mariana M. Vale, Peter R. Hobson, Nuria Selva. 2016. A global map of roadless areas and their conservation status. SCIENCE 16 DEC 2016 : 1423-1427. http://science.sciencemag.org/content/354/6318/1423

The Forest Service defines unroaded areas as any area without the presence of classified roads, and of a size and configuration sufficient to protect the inherent characteristics associated with its roadless condition. http://web.archive.org/web/20010729111100/http://roadless.fs.fed.us/documents/feis/glossary.shtml. Unroaded areas greater than about 1,000 acres, whether they have been inventoried or not provide valuable natural resource attributes that must be protected. These include: water quality; healthy soils; fish and wildlife refugia; centers for dispersal, recolonization, and restoration of adjacent disturbed sites; reference sites for research; non-motorized, low-impact recreation; carbon sequestration; refugia that are relatively less at-risk from noxious weeds and other invasive non-native species, and many other significant values. See Forest Service Roadless Area Conservation FEIS, November 2000.

Former Secretary of Agriculture Tom Vilsack recognizes the value of National Forest roadless areas: "Roadless areas preserve essential watersheds and help ensure an abundant supply of clean drinking water. These large areas of undisturbed forests provide diverse habitats for sensitive and endangered wildlife. In addition, roadless areas provide other critical ecological services, such as carbon storage, and operate as effective barriers to invasive species, while also providing social values such as scenic landscapes and a host of recreational opportunities. Let me assure you that USDA and the Forest Service will move forward to conserve and protect these lands and meet all legal obligations." March 11, 2009 letter to Oregon Governor Ted Kulongoski.

Before logging roadless areas the agency should consider the impacts to all the values of roadless areas, including:

(1) High quality or undisturbed soil, water, and air;
(2) Sources of public drinking water;
(3) Diversity of plant and animal communities;
(4) Habitat for threatened, endangered, proposed, candidate, and sensitive species and for those species dependent on large, undisturbed areas of land;
(5) Primitive, semi-primitive non-motorized and semi-primitive motorized classes of dispersed recreation;
(6) Reference landscapes;
(7) Natural appearing landscapes with high scenic quality;
(8) Traditional cultural properties and sacred sites; and
(9) Other locally identified unique characteristics.

36 CFR §294.11 (2001).
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5050459.pdf

The agency can develop a preliminary map of roadless/unroaded areas >1,000 acres by simply querying your GIS database for polygons between roads that are >1,000 acres. This preliminary map can be made more accurate by subtracting regen harvest units younger than 50 years.

Oregon Wild conducted such an inventory as follows:

> Oregon Wild's Citizen Roadless Inventory is shown on interactive statewide map available at http://www.oregonwild.org/explore-oregon/oregon-wild-map-gallery by following the link for "All Potential Forest Wilderness." We generally define these areas as those that meet the criteria for inventoried roadless areas set forth by the USFS but based on new science showing the significant ecological value sof unroaded areas >1,000 acres, we applied the criteria to federal land areas over 1,000 acres. They are generally in fairly good shape with no substantial/obvious logging, development, or roads.
>
> These areas have wilderness qualities and may qualify for Wilderness protection. There are many other significant values that make these areas worthy of special attention including (but not limited to) their value as places where natural processes can do the ecological work and as a control to experiments (intentional and otherwise) being done across a landscape dominated by human activities including commercial logging, mining, grazing, road building, and other development.
>
> The Forest Service defines unroaded areas as any area without the presence of classified roads, and of a size and configuration sufficient to protect the inherent characteristics associated with its roadless condition. http://web.archive.org/web/20010729111100/http://roadless.fs.fed.us/documents/feis/glossary.shtml. While we refer to Forest Service guidelines in identifying these areas, FS

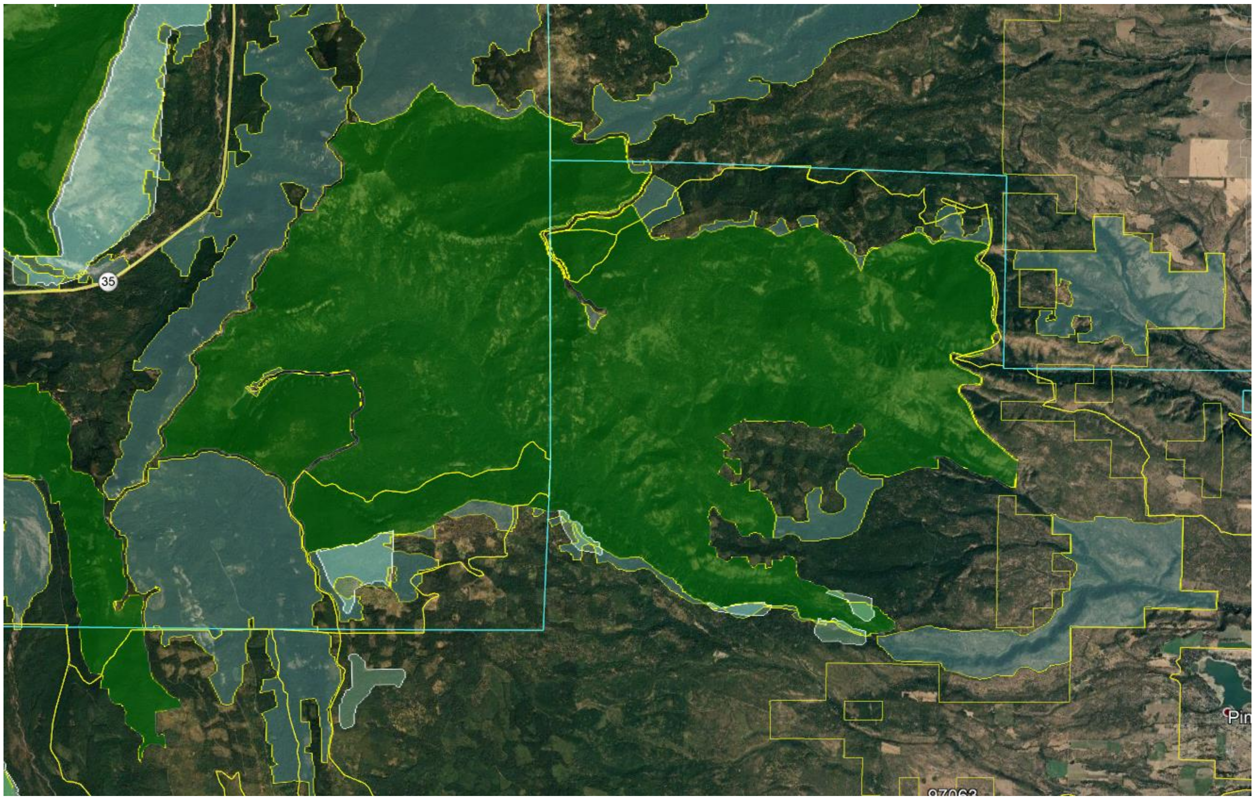
inventories such as RARE II are not the final word. In addition to errors made during the inventory, there are a number of exclusionary biases in defining potential wilderness area's and the roadless inventory. Furthermore, science has evolved since that time to recognize significant ecological value in areas smaller than 5,000 acres.

To identify these areas, Oregon Wild started with a GIS query. Using the most current data layers available for existing roads, we identified all polygons >1,000 acres bounded by those roads. Using GIS layers, we excluded non-federal lands, clearcuts, and heavy thins. We then used aerial images to further refine boundaries based on obvious developments, roads, quarries, and other logging areas not previously identified. We then recruited volunteers to "adopt" candidate unroaded areas and ground-truth them to the extent possible by adding and subtracting areas based on ground reconnaissance. While not every area has been ground-truthed, we update the inventory as we receive information from individuals and agencies during project planning and at other times. Our inventory of unroaded areas is a work-in-progress with a fairly high level of accuracy.

The NEPA analysis should discuss whether the project will push the landscape toward or away from the natural range of variability for large-scale habitat patches. Landscape analysis based on historic disturbance patterns suggests that historically the majority of old forest occurred in large patches. See Wimberly, M. 2002. Spatial simulation of historical landscape patterns in coastal forests of the Pacific Northwest. Can. J. For. Res. 32:13-16-1328 (2002) http://andrewsforest.oregonstate.edu/pubs/pdf/pub2859.pdf (72% of the total mature forest in the Oregon Coast Range was concentrated in patches >1,000 ha). These large patches of older forests that native fish and wildlife species evolved with are now severely underrepresented on the forest landscape and must be protected and restored.

The Northwest Forest Plan LSOG Effectiveness Monitoring Plan says that "perhaps 80 percent or more [of the historic late-successional old-growth forest] would probably have occurred as relatively large (greater than 1,000 acres) areas of connected forest." Miles Hemstrom, Thomas Spies, Craig Palmer, Ross Kiester, John Teply, Phil McDonald, and Ralph Warbington; Late-Successional and Old-Growth Forest Effectiveness Monitoring Plan for the Northwest Forest Plan, USFS General Technical Report PNW-GTR-438; December 1998; http://www.fs.fed.us/pnw/pubs/gtr_438.pdf. Currently, these 1,000 acre and larger patches are rare on the landscape.

Please disclose the adverse effects of logging and roads in the roadless area (blue polygons) in the map below. Unroaded areas larger than 1,000 acres are rare and under-represented. The Forest Service should include a purpose and need to restore such areas.



The agency cannot limit its analysis of roadless areas to inventoried areas >5,000 acres, because smaller roadless areas that were not inventoried are ecologically relevant and potentially significant. The NEPA analysis must reflect the growing scientific evidence (cited below) indicating the significant value of roadless areas smaller than 5,000 acres and larger than 1,000 acres. Recent scientific literature emphasizes the importance of unroaded areas greater than 1,000 acres as strongholds for the production of fish and other aquatic and terrestrial species, as well as sources of high quality water. Commercial logging and/or road building within large unroaded areas threatens these significant ecological values.

Why Mature Forests Must be Protected.

> "As recognized by FEMAT, a conservation strategy for the Pacific Northwest must consider mature forests as well as OG. Forests are considered to enter maturity when their mean annual increment culminates, following which time they begin developing the characteristics that ultimately produce OG. Mature forests serve various important ecologic functions. They serve as future replacements for old-growth, help protect existing OG by reducing the starkness of age-class boundaries, and provide landscape connectivity and transitional habitat that compensate to some degree for the low levels of OG. Moreover, they are almost certainly more resistant to crown fires than younger forests, and hence contribute to buffering the landscape."

Late-Successional and Old-Growth Forests in the Pacific Northwest. Statement of DAVID A. PERRY Professor Emeritus. Department of Forest Science, Oregon State University, before the

Subcommittee on Public Lands and Forests of the Committee on Energy and Natural Resources, United States Senate. March 13, 2008.

All logging, including thinning stands of any age, include some adverse impacts and trade-offs. Some impacts of logging are unavoidable, so there is no such thing as a logging operation that is 100% beneficial. Depending on how thinning is done thinning can have adverse impacts such as soil disturbance, habitat disturbance, carbon removal, spreading weeds, reduced recruitment of snags, road-related erosion and hydrologic impacts, moving fuels from the canopy to the ground, creating a hotter-drier-windier microclimate that is favorable to greater flame lengths and rate of fire spread, etc. Some of these negative effects are fundamentally unavoidable, therefore all thinning has negative effects that must be compensated by beneficial effects such as reducing competition between trees so that some can grow larger faster, increased resistance drought stress and insects, increasing species diversity, possible fire hazard reduction, etc. It is generally accepted that when thinning very young stands, the benefits outweigh the adverse impacts and net benefits are likely. It is also widely understood that thinning older stands tends to have greater impacts on soil, water, weeds, carbon, dead wood recruitment so the impacts very often outweigh the benefits, resulting in net negative outcome on the balance sheet. As we move from young forest to older forests, the net benefits turn into net negative impacts, but where is that line? The authors of the Northwest Forest Plan took all this into account and determined that 80 years is a useful place to draw the line between forests that are likely to benefit from silviculture and those that are likely to experience net negative consequences. There is no new science to change that conclusion. In fact, new information developed since 1994 shows that dead wood is probably more valuable than previously thought - being important for a wide variety of ecological functions, not least of which is providing complex habitat that supports prey species for spotted owl and a variety of other predators both east and west of the Cascades. As stands become mature at around 80 years of age, they begin accumulating snags and dead wood from natural mortality processes. Thinning "captures mortality" and removes it from the forest thus preventing those trees from ever becoming snags and dead wood and interrupting the critical process whereby mature forests accumulate dead wood. The loss of recruitment of dead wood habitat when logging older stands is a long-term impact and provides a very strong argument against logging in stands over 80 years old. For further information see 1993 SAT Report pp 146-152. AND February 1991 Questions and Answers on A Conservation Strategy for the Northern Spotted Owl (prepared in response to written questions from the Senate Energy and Natural Resources Committee to the Interagency Scientific Committee on the May 1990 ISC Report. AND Jerry Franklin, David Perry, Reed Noss, David Montgomery, Christopher Frissell. SIMPLIFIED FOREST MANAGEMENT TO ACHIEVE WATERSHED AND FOREST HEALTH: A CRITIQUE. National Wildlife Federation. http://www.coastrange.org/documents/forestreport.pdf.

The agency needs to recognize the distinction between thinning young plantations and thinning mature forests. Robert Anthony reminded the regional executives in 2013 that:

> The long-term benefits of thinning in young plantations to create forests with characteristics of late-successional forests (e.g. large diameter standing and down wood) may outweigh any short-term negative effects on owls or their prey. However, as the age of forests selected for thinning increases, the short-term negative effects of such activities will likely increase and the benefits decrease. The Northwest Forest Plan specified a maximum age of 80 years for forests that are slated for thinning. The reasons for this guideline were that (1) it was unclear if thinning could actually accelerate the rate at which naturally regenerated mature forests developed old forest conditions, and (2) spotted owls forage in mature forests, and thinning of these forests will likely reduce their quality as spotted owl habitat both in the short and long term. If these young forests are not currently good foraging habitat, they are gradually developing late-successional characteristics that will provide foraging habitat in the near future. Consequently, thinning in riparian forests >80 years old or any younger forests where thinning is not likely to accelerate the development of late-successional forest structure is not recommended. If these young forests are not currently good foraging habitat, they are gradually developing late-successional characteristics that will provide foraging habitat in the near future. Consequently, thinning in riparian forests >80 years old or any younger forests where thinning is not likely to accelerate the development of late-successional forest structure is not recommended.

Anthony, R.G. 2013. "Effects of Riparian Thinning on Marbled Murrelets and Northern Spotted Owls." Part III of the Science Review Team for the identification and interpretation of the best available scientific information to determine effects of riparian forest management. 28 January 2013.

The agency must carefully review and document their consideration of all the reasons not to log mature forests set forth in this paper: Doug Heiken 2009. The Case for Protecting Both Old Growth and Mature Forests. Version 1.8 April 2009. https://www.dropbox.com/s/4s0825a7t6fq7zu/Mature%20Forests%2C%20Heiken%2C%20v%201.8.pdf?dl=0.

Skeena Watershed Council in British Columbia note that "Old growth forests are now a non-renewable resource. They will not be replaced with new growth due to climate change. While the forest will grow, we will not see trees get as large or as old as the ones we have now."

Lutz (and 95 co-authors!) compiled detailed forest plot data from 48 sites around the world and found that large trees play critical roles in forest structure and function (especially carbon storage), yet they are vulnerable to disturbance (especially logging) and take a long time to replace, so they need to be conserved.

Main conclusions: Because large-diameter trees constitute roughly half of the mature forest biomass worldwide, their dynamics and sensitivities to environmental change represent potentially large controls on global forest carbon cycling. We recommend managing forests for conservation of existing large-diameter trees or those that can soon reach large diameters as a simple way to conserve and potentially enhance ecosystem services.

...

Concentration of resources within a few individuals in a community is a pervasive property of biotic systems (West, Brown, & Enquist, 1997), whether marine (Hixon, Johnson, & Sogard, 2014), terrestrial (Enquist, Brown, & West, 1998) or even anthropogenic (Saez & Zucman, 2016). The concentration of total forest biomass in a few large-diameter trees is no exception (Pan, Birdsley, Phillips, & Jackson, 2013). Large-diameter trees in forests take many decades or even centuries to develop, but human or natural disturbances can decrease their abundance, rapidly changing forest structure (Allen et al., 2010; Lindenmayer, Laurance, & Franklin, 2012; Lutz, van Wagtendonk, & Franklin, 2009; van Mantgem et al., 2009).

... Previous studies have showed that large-diameter trees comprise a large fraction of the biomass of many forests (Bastin et al., 2015; Brown et al., 1995; Clark & Clark, 1996; Lutz, Larson, Swanson, & Freund, 2012) and that they modulate stand-level leaf area, microclimate and water use (Martin et al., 2001; Rambo & North, 2009). Large-diameter trees contribute disproportionately to reproduction (van Wagtendonk & Moore, 2010), influence the rates and patterns of regeneration and succession (Keeton & Franklin, 2005), limit light and water available to smaller trees (Binkley, Stape, Bauerle, & Ryan, 2010), and contribute to rates and causes of mortality of smaller individuals by crushing or injuring sub-canopy trees when their bole or branches fall to the ground (Chao, Phillips, Monteagudo, Torres-Lezama, & Vasquez Martínez, 2009; Das, Stephenson, & Davis, 2016). Large-diameter trees (and large-diameter snags and large-diameter fallen woody debris) make the structure of primary forests and mature secondary forests unique (Spies & Franklin, 1991). Large-diameter trees occur at low stem densities, yet influence spatial patterns over long inter-tree distances (Das, Larson, & Lutz, 2018; Enquist, West, & Brown, 2009; Lutz et al., 2014). ...

... Changes in climate, disturbance regimes and logging are accelerating the decline of large-diameter trees (e.g., Bennett, McDowell, Allen, & Anderson-Teixeira, 2015; Lindenmayer & Laurence, 2016; Lindenmayer et al., 2012). The dynamics of large-diameter trees is dependent on at least two factors: (a) presence of species capable of attaining a large size, and (b) conditions, including disturbance regimes, that permit the development of large-diameter individuals. If the species richness of the large-diameter assemblage is high, a forest may be better able to respond to perturbations (Musavi et al.,

2017) and maintain its structure and ecological function. However, if the largediameter species richness is low, then a forest could be susceptible to any change that affected those few species.

...

DISCUSSION

The relationship between the large-diameter threshold and overall biomass (Figure 2a) suggests that forests cannot sequester large amounts of aboveground carbon without large trees, ...

...

Temperate forests featured a higher density of trees $\geq$ 60 cm DBH (Table 1), consistent with the presence of the very largest species of trees in cool, temperate forests (Sillett et al., 2015; Van Pelt et al., 2016). Temperate forests also exhibited considerably lower densities of small trees (e.g., 1 cm $\leq$ DBH < 5 cm; Supporting Information Table S3.2) and lower total stem density.

...

There is still considerable uncertainty as to what will happen to large-diameter trees in the Anthropocene when so much forest is being felled for timber and farming, or is being affected by climate change. Bennett et al. (2015) suggested that the current large-diameter trees are more susceptible to drought mortality than smaller-diameter trees. Larger trees, because of their height, are susceptible to sapwood cavitation and are also exposed to high radiation loads (Allen, Breshears, & McDowell, 2015; Allen et al., 2010), but vigorous large-diameter individuals may also still be sequestering more carbon than smaller trees (Stephenson et al., 2014). Both Allen et al. (2015) and Bennett et al. (2015) suggested that larger trees will be more vulnerable to increasing drought than small trees, and Luo and Chen (2013) suggested that although the rate of mortality of larger trees will continue to increase because of global climate change, smaller trees will experience more drought-related mortality. These last two conclusions need not be in conflict as the background mortality rates for smaller trees are higher than those of larger trees within mature and old-growth forests (Larson & Franklin, 2010). What remains generally unanswered is whether the increasing mortality rates of large-diameter trees will eventually be offset by regrowth of different individuals of those same (or functionally similar) species. ...

... The conservation of large-diameter trees in tropical and temperate forests is therefore imperative to maintain full ecosystem function, as the time necessary for individual trees to develop large sizes could preclude restoration of full ecosystem function for centuries following the loss of the oldest and largest trees (Lindenmayer et al., 2012). Clearly, areas that have been recently logged lack large-diameter trees, and therefore have less structural heterogeneity than older forests. That the largest individuals belong to relatively few common species in the temperate zone means that the loss of large-diameter trees could alter forest function – if species that can attain large diameters disappear, forests will feature greatly reduced structural heterogeneity (e.g., Needham et al., 2016), biomass, and carbon storage.

Lutz et al (2018). Global importance of large-diameter trees. Global Ecology and Biogeography. 2018:1-16. DOI: 10.1111/geb.12747. http://www.columbia.edu/~mu2126/publications_files/Lutz_et_al-2018-Global_Ecology_and_Biogeography.pdf

Conservation of mature & old-growth trees helps achieve social goals. The social importance of conserving large trees is often under-appreciated. See Blicharska et al. (2014).

Abstract: In addition to providing key ecological functions, large old trees are a part of a social realm and as such provide numerous social-cultural benefits to people. However, their social and cultural values are often neglected when designing conservation policies and management guidelines. We believe that awareness of large old trees as a part of human identity and cultural heritage is essential when addressing the issue of their decline worldwide. Large old trees provide humans with aesthetic, symbolic, religious, and historic values, as well as concrete tangible benefits, such as leaves, branches, or nuts. In many cultures particularly large trees are treated with reverence. … Although the social and cultural role of large old trees is usually not taken into account in conservation, accounting for human-related values of these trees is an important part of conservation policy because it may strengthen conservation by highlighting the potential synergies in protecting ecological and social values.

Recognition of Social and Cultural Values of Large Old Trees

Large old trees have important ecological functions (Lindenmayer et al. 2012, 2013), but they often have enormous social significance as well; therefore, protecting them for ecological reasons also supports maintenance of aesthetic, symbolic, religious, and historic values (i.e., these different kinds of values can be protected in a synergetic manner).

Many conservation policies already highlight the necessity to include people, their needs, and values in conservation decisions. … both tangible and intangible benefits provided by large old trees can be directly translated into the ecosystem services concept.

… The context in which issues are represented has the potential to affect the actual action because context induces particular ways of understanding the issue and thus may lead to new types of actions in the policy process (Hajer 1995). Therefore, framing the conservation of large old trees from a human perspective, for whom they are protected and for whom they deliver important services,

may facilitate creation and implementation of relevant policies.

… This flagship function of large old trees appears to be more universal than that for other types of flagship species. The latter are usually limited to a particular environment and geographic area, whereas large old trees are highly valued by humans across cultural and environmental realms.

Blicharska, M.; Mikusiński, G. 2014. Incorporating social and cultural significance of large old trees in conservation policy. Conserv. Biol. 28(6):1558-1567. http://www.researchgate.net/profile/Grzegorz_Mikusinski2/publication/264673453_Incorporating_social_and_cultural_significance_of_large_old_trees_in_conservation_policy/links/5495bc800cf29b9448241278.pdf

The complex structure and multi-layered canopy of mature & old-growth forests provides a buffer against thermal extremes which means that older forests can serve as climate refugia as the climate warms. OPB interviewed one of the authors of the study and reported:

> … the kind of forest makes a big difference on temperature.
>
> "The more structurally complex the forest, the more big trees, the more vertical layers – the cooler it was," he says.
>
> The research showed differences as much as 4.5 degrees on warm days. Old growth forests also held in heat during cold weather. Overall, these forests have a moderating effect on temperature extremes.
>
> One reason, researchers suspect, is that tree plantations, even mature ones, don't have nearly the understory material – small trees, shrubs, ground cover – as more complex stands. Nor do these single-age plantations have a lot of big trees – unlike old growth stands.
>
> "We think one of the mechanisms causing this is thermal inertia," Betts says. "That takes these trees longer to warm up and longer to cool down. And that could be providing some of the buffering capacity of these older forests."
>
> Betts says these stands of old growth could provide refuges for temperature-sensitive wildlife in the face of climate change.

Jes Burns 2016. Old-Growth Forests Provide Temperature Refuges In Face Of Climate Change: Study. OPB/EarthFix | April 22, 2016 http://www.opb.org/news/article/forest-refuges-climate-change/ *citing* Sarah J. K. Frey, Adam S. Hadley, Sherri L. Johnson, Mark Schulze, Julia A. Jones, Matthew G. Betts. 2016. Spatial models reveal the microclimatic buffering capacity of old-growth forests. SCIENCE ADVANCES. 22 APR 2016 : E1501392. http://advances.sciencemag.org/content/advances/2/4/e1501392.full.pdf.

> Pre-fire nesting/roosting habitat had lower probability of burning at moderate or high severity compared to other forest types under high burning conditions. Our results

indicate that northern spotted owl habitat can buffer the negative effects of climate change by enhancing biodiversity and resistance to high-severity fires, which are predicted to increase in frequency and extent with climate change. Within this region, protecting large blocks of old forests could be an integral component of management plans that successfully maintain variability of forests in this mixed-ownership and mixedseverity fire regime landscape and enhance conservation of many species.

Lesmeister, D. B., S. G. Sovern, R. J. Davis, D. M. Bell, M. J. Gregory, and J. C. Vogeler. 2019. Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere 10(4):e02696. 10.1002/ecs2.2696. https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/ecs2.2696. The PNW Research Station put out a press release on this study on July 2, 2019 which said:

> Old-growth forests have more vegetation than younger forests. Researchers expected that this meant more fuel would be available for wildfires, increasing the susceptibility of old-growth forests to severe fire, high tree mortality, and resulting loss of critical spotted owl nesting habitat. However, the data suggested a different effect.
>
> Lesmeister and his colleagues classified fire severity based on the percentage of trees lost in a fire, considering forest that lost less than 20% of its trees to fire subject to low-severity fire and those with more than 90% tree loss subject to high-severity fire. They found that old-growth forest was up to three times more likely to burn at low severity–a level that avoided loss of spotted owl nesting habitat and is generally considered to be part of a healthy forest ecosystem.
>
> "Somewhat to our surprise, we found that, compared to other forest types within the burned area, old-growth forests burned on average much cooler than younger forests, which were more likely to experience high-severity fire. How this actually plays out during a mixed-severity wildfire makes sense when you consider the qualities of old-growth forest that can limit severe wildfire ignitions and burn temperatures, like shading from multilayer canopies, cooler temperatures, moist air and soil as well as larger, hardier trees."
>
> Because old-growth forests may be refuges of low-severity fire on a landscape that experiences moderate to high-severity fires frequently, they could be integral as biodiversity refuges in an increasingly fire-prone region.

U.S. Forest Service Pacific Northwest Research Station 2019. Old-growth forest may provide valuable biodiversity refuge in areas at risk of severe fire. July 8, 2019. https://yubanet.com/california/old-growth-forest-may-provide-valuable-biodiversity-refuge-in-areas-at-risk-of-severe-fire/; https://www.fs.usda.gov/pnw/news-releases/old-growth-forests-may-provide-valuable-biodiversity-refuge-areas-risk-severe-fire.

Betts et al (2017) also found old growth to be of value to wildlife in terms of microclimate buffering:

> **Results**

We found a significant negative effect of summer warming on only two species. However, in both of these species, this relationship between warming and population decline was not only reduced but reversed, in old-growth-dominated landscapes. Across all 13 species, evidence for a buffering effect of old-growth forest increased with the degree to which species were negatively influenced by summer warming.

Main conclusions

These findings suggest that old-growth forests may buffer the negative effects of climate change for those species that are most sensitive to temperature increases. Our study highlights a mechanism whereby management strategies to curb degradation and loss of old-growth forests—in addition to protecting habitat—could enhance biodiversity persistence in the face of climate warming.

Matthew G. Betts, Ben Phalan, Sarah J. K. Frey, Josée S. Rousseau, Zhiqiang Yang. 2017. Old-growth forests buffer climate-sensitive bird populations from warming. Diversity and Distributions. Volume 24, Issue 4. April 2018. Pages 439-447, https://doi.org/10.1111/ddi.12688. See also, USDA/USDI 1994. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. Vol I, pp 3&4-29 -31. https://www.blm.gov/or/plans/nwfpnepa/ ("Small patches of old-growth forest can provide thermal and mesic refugia for a variety of organisms. Understory habitats in old-growth forests can escape freezing conditions due to the thermal buffering of dense tree canopies. Deer and other vertebrates may rely on these thermal refuges during harsh storms or during dispersal to larger forest stands of suitable habitat. Many invertebrates migrate locally to mesic refugia during summer. During very dry periods in forests east of the Cascade Range, many invertebrates may require dense forest cover and mesic understory habitats to avoid desiccation").

Tree height is an indicator of old growth habitat suitability. This is likely because tree height is a direct measure of 3-dimensional habitat volume below the tree tops. North, Kane, Kane, et al 2017.Cover of tall trees best predicts California spotted owl habitat. Forest Ecology and Management. 405: 166-178. https://doi.org/10.1016/j.foreco.2017.09.019, https://www.fs.fed.us/psw/pubs/55075, https://www.fs.fed.us/psw/publications/north/psw_2017_north004.pdf, https://www.fs.fed.us/psw/news/2017/20171005_spottedowl.shtml ("Although total canopy cover was high in nest stands and PAC [protected activity center] areas, the cover in tall (>48m) trees was the canopy structure most highly selected for, while cover in lower strata (2–16m) was avoided compared to availability in the surrounding landscape. … High canopy cover (≥70%) mostly occurs when large tree cover is high, indicating the two variables are often confounded. ... [T]he cover of tall trees may be a better predictor of owl habitat than total canopy cover because the latter can include cover in the 2–16 m strata – conditions that owls actually avoid.") This study seems to indicate that California spotted owls, and maybe northern spotted owls, are OK with relatively simple stands of tall trees with high canopy cover in the overstory. They don't necessarily need or prefer complex stands with multiple cohorts and lower canopy layers. The agencies therefore should NOT intervene with logging to reduce canopy cover of tall trees in order to establish new cohorts to benefit spotted owls.

The agency must protect mature forests because they are the best candidates to grow and develop into old-growth habitat in the shortest time frame.

1. There is a serious region-scale deficit in mature and old-growth forest habitat. Over time, the Northwest Forest Plan seeks to re-establish 3.44 million acres of mature and old-growth forest (http://web.archive.org/web/20030402090844/http://www.fs.fed.us/land/fm/oldgrow/oldgrow.htm). By continuing to log mature forests we are significantly delaying this recovery. If we are going to make a timely recovery from that deficit, and give struggling species a chance to survive the habitat bottleneck that we have created, we must protect mature forests so that they can become old-growth, and we must manage young forest so they can become mature.
2. The transition from mature forest to old growth is a process that takes time and varies depending on factors such as location and species and disturbance events. In a mature forest, all the ingredients are there to make old growth (e.g., large trees) and the scientists agree that these forests need protection to help meet the current old-growth forest deficit.
3. The architects of the Northwest Forest Plan found that many of our best large intact forest landscapes are mature forests, not old-growth. Some large forest fires burned westside forests between 1840 and 1910 and many such areas were skipped over by the timber harvest planners because they were more intent on converting the very old forests to tree plantations. These former fire areas, now mature forests, offer some of our best hopes of recreating large blocks of intact older forest.
4. Cutting mature forests is not needed for ecological reasons. These forests are already exhibiting the characteristics that provide excellent habitat and they continue to develop and improve without human intervention. As recognized in the Northwest Forest Plan standards and guidelines for Late Successional Reserves, stands over 80 years old do not need to be manipulated to become old-growth. All the ingredients are there, they just need time.
5. Mature forests provide essential habitat for the species we are most concerned with such as: spotted owl, marbled murrelet, Pacific salmon, and most of the "survey and manage" species.
6. Protecting mature and old-growth forest leads to a real ecological solution, while protecting only old-growth is merely a partial solution to an ecological problem that is bigger than just old-growth.
7. Cutting mature forest will remain controversial and socially unacceptable. If we seek to resolve conflict over management of older forests, protecting the old-growth while leaving mature forests unprotected would be only half a solution and would lead to more

conflict. Shifting to a restoration paradigm gets everyone at the table working toward the same goal.

8. If mature forest is left unprotected, some members of the environmental community will distrust the agencies and oppose them on many fronts.
9. Leaving mature forests unprotected would leave substantial areas of roadless lands subject to future conflict. Many westside roadless areas may not qualify as old-growth, but still provide important values as roadless and mature forests.
10. Complicated environmental analysis will be required for logging mature forests compared to thinning plantations. Wildlife surveys will be needed. Environmental Impact Statements will more often be needed instead of abbreviated Environmental Assessments. Formal consultation under the Endangered Species Act will more often be triggered.
11. We do not need to log mature forest to provide jobs. Less than 2% of the jobs in Washington and Oregon are in the lumber and wood products sectors, and only a small fraction of those are on federal land and only a fraction of those are related to mature forest logging. Many more environmentally benign jobs are available in restoring roads, streams, thinning young plantations, and managing fire and recreation.
12. We do not need to log mature forest to prop up the economy. The NW economy has greatly diversified in the last decade. Our economy typically creates more new jobs every year than exist in the entire lumber and wood products sectors.
13. We do not need to log mature forest to prop up the timber industry. Less than 10% of the logging in Oregon and Washington in recent years has been on federal lands. Only a fraction of that is mature forest. Much more environmentally benign and socially acceptable timber can be derived from thinning young plantations or small diameter fuel reduction where it is appropriate.
14. Since managing these stands is not "needed" for any ecological reason or any economic or social reason, what would be the objective?
15. Standing in a mature forest, once gets the distinct feeling that “this beautiful place should not be destroyed by logging.”

Logging in riparian reserves older than 80 years.
The agency must carefully explain why they think it’s OK to thin stands over 80 years old in riparian reserves but not in LSRs when the goals are similar. Two of the main authors of the Northwest Forest Plan recently stated that “Riparian Reserves which have similar structural goals as the LSRs … A maximum thinning age of 80 years was used here.” Johnson & Franklin 2009. Restoration of Federal Forests in the Pacific Northwest: Strategies and Management Implications.
http://fes.forestry.oregonstate.edu/sites/fes.forestry.oregonstate.edu/files/PDFs/RestorationOfFederalForestsInThePacificNorthwest.pdf (p 49).

FEMAT page IV-109 says that logging in riparian reserves stands older than 80 years is not appropriate. Such stands were presumed to remain unharvested as mitigation for Bryophytes and other species that prefer dense forest cover and abundant dead wood.

> **Mitigation for Bryophytes**
> Bryophytes should receive considerable protection under riparian prescriptions, especially those with full SAT riparian buffers. … Riparian stands older than 80 years should not be thinned or harvested.

"Findings: Thinning is most beneficial in dense young stands <80 years and less clear in older stands." Chatel 2016. Riparian Management and ESA. Presentation at USFS Ecology Group meeting in Joseph, Oregon. 2016. http://ecoshare.info/whats-new/annual-reports/presentations-at-2016-annual-meeting-in-joseph-or/; http://ecoshare.info/uploads/annualMeeting2016/Riparian-Management-and-ESA-Chatel.pptx *referencing* Science Review Team, NW Oregon Riparian Reserve Tree Thinning Elevation.

Critical Habitat is for recovery, not just avoiding jeopardy

We urge the agency to avoid logging suitable nesting, roosting, foraging habitat, especially within critical habitat. Discussions about "disturbance" and "ecological processes" in the 2012 final critical habitat rule for the northern spotted owl raises some serious concerns. Spotted owls are more associated with ecological processes that add forest rather than remove forest, such as such as photosynthesis, biomass accumulation, canopy closure, and later stages of successional development. The critical habitat rule seems to suggest that variable retention regen harvest may benefit spotted owls. This is a testable hypothesis but is not at all supported by the evidence. Stand replacing disturbance will degrade, not enhance, spotted owl habitat. In fact, the spotted owl's primary threat is too much stand replacing disturbance, and the landscape is still recovering from the decades-long (and still ongoing) reign of excessive clearcutting. Furthermore, fire and other natural disturbances continue to occur, so natural stand replacing (and intermediate) disturbance events have their place and are already occurring. If we add significant stand replacing human disturbance to the cumulative effects of natural disturbance, it is likely to jeopardize the species.

This project occurs in designated critical habitat. This raises several concerns:

1. The agency must physically protect and restore designated critical habitat to achieve "recovery" not just maintain the species in bare survival mode. This is the legal mandate of the ESA as reflected in three circuit court opinions Gifford Pinchot Task Force v. Norton 378 F.3d 1059 (9th Circ. August 6, 2004), Sierra Club v. U.S. Fish and Wildlife Service, No. 00-30117 (5th Cir. Mar. 15, 2001). N.M. Cattle Growers Ass'n v. United States Fish and Wildlife Serv., 248 F.3d 1277, 1283 & n.2 (10th Cir. 2001).
2. Meeting the recovery standard is not only an ESA issue, but also a NEPA issue. The agency is required by law to properly frame its NEPA analysis so that legal mandates are clearly apparent and the consequences of the proposed action are compared to the

applicable legal standards. The NEPA document must therefore disclose primary constituent elements of critical habitat, the current condition of the affected CHU, and how this CHU may fit into recovery and conservation efforts for listed species. The NEPA analysis for this project fails to make these disclosures and inappropriately aims to avoid *jeopardy* rather than contribute to *recovery*. NEPA requires that the agency properly frame its legal duties so it can accurately disclose whether it is complying with the law. FSH 1909.15 Chapter 40, 43.21. 40 CFR 15087.27(b)(10). *NW Indian Cemetery Protective Association v. Peterson*, 795 F2d 688 (9th Circ. 1986). *SAS v. Mosely*, 798 F.Supp. 1473 (W.D. Wash. May 1992). *ONRC Action v. U.S. Forest Service*, CV. 03-613-KI (October 2003). *Klamath Siskiyou Wildlands Center v. Boody* (#03-3124-CO, May 18, 2004).

3. The agency must comply with the ESA by formally consulting with the FWS on the effect of this project on spotted owl recovery. Gifford Pinchot Task Force v. Norton 378 F.3d 1059 (9th Circ. August 6, 2004). If the agency has already consulted and the biop does not address in detail how this project will contribute to or detract from recovery, then consultation must be reinitiated.

In the absence of a recovery plan, the agency must retain all options for species recovery and avoid taking actions that will limit options for recovery.

The agency must follow the holding of the 9th Circuit.

> … the ESA was enacted not merely to forestall the extinction of species (i.e., promote a species survival), but to allow a species to recover to the point where it may be delisted. *See* 16 U.S.C. § 1532(3) (defining conservation as all methods that can be employed to "bring any endangered species or threatened species to the point at which the measures provided pursuant to this [Act] are no longer necessary"); *Sierra Club*, 245 F.3d at 438.
> … Clearly, then, the purpose of establishing "critical habitat" is for the government to carve out territory that is not only necessary for the species' survival but also essential for the species' recovery.

Gifford Pinchot Task Force v. Norton 378 F.3d 1059 (9th Circ. August 6, 2004).
http://web.archive.org/web/20041101124018/http://www.ca9.uscourts.gov/ca9/newopinions.nsf/57987D956468797888256EE800581847/$file/0335279.pdf?openelement

> A recent federal court decision may lead the federal government to designate more lands as "critical habitat" of endangered species and impose more restrictions on the use of those lands. The Fifth Circuit ruled in Sierra Club v. U.S. Fish and Wildlife Service, No. 00-30117 (5th Cir. Mar. 15, 2001), that the U.S. Fish and Wildlife Service and National Marine Fisheries Service had improperly interpreted the Endangered Species Act to provide for the designation and protection of critical habitat essential to the "survival" of listed species. According to the court, the Act calls on the Services to aim higher-and designate and protect critical habitat essential to the "recovery" of listed species.
> …

> The Endangered Species Act, noted the court, defines "conservation" as "the use of all methods and procedures which are necessary to bring any endangered... or threatened species to the point at which the measures provided by the [Act] are no longer necessary." This, said the court, "is a much broader concept than mere survival" that "speaks to the recovery of a threatened or endangered species." As the Services' standard for destruction or adverse modification protected critical habitat only from actions decreasing the likelihood of the *survival and recovery* of a listed species, the court found it inconsistent with Congress' intent as expressed in the Act.

http://web.archive.org/web/20020912045735/http://www.stoel.com/resources/articles/environment/news-mar01-2.shtm

The agency needs to avoid adverse modification of critical habitat, including actions that cause incremental loss of habitat. An October 2014 letter from conservation groups to the Secretary of Interior reminds the government of the fundamental fact that incremental actions can lead to cumulatively significant effects:

> Controlling and preventing the destruction of critical habitat is not easy because most habitat loss occurs gradually and incrementally over time. Very rarely does a single project threaten an entire species, as was the case with the snail darter and Tellico Dam in Tennessee Valley Authority v. Hill. [437 U.S. 153 (1978).] Instead many species become endangered by hundreds or thousands of small independent actions and decisions. Minor impacts to critical habitat may not at first appear significant, but over time the cumulative impact of many, small changes can have a profound effect on endangered species habitats. It is these "death-by-a-thousand-cuts" scenarios that drive species decline in many cases in the United States, and it is these scenarios that the proposed rule fails to address properly.
>
> The Services' proposed regulatory definition for "destruction or adverse modification" fails to address incremental and cumulative impacts of small harms in two important and related ways. First, the proposed rule states that only those negative changes that "appreciably diminish" the conservation value of critical habitat will be addressed during the consultation process under the ESA. Second, the proposed rule specifies that in determining whether an impact does "appreciably diminish" critical habitat, the Services will only evaluate impacts at the scale of the entire critical habitat designation. These two aspects of the proposal are not supported by the best available science and undermine the spirit and intent of the ESA.
>
> As an initial matter, when Congress passed the ESA in 1973 and amended the law in 1978, it did not require the destruction or adverse modification of critical habitat to be "appreciable." Instead, it simply prohibited federal activities that destroyed or adversely modified critical habitat. In contrast, in Section 0(a)(1)(B) of the ESA, Congress permitted private activities that could incidentally take listed species so long as those activities would not "appreciably reduce the likelihood of the survival and recovery of the

species in the wild." This crucial distinction recognizes that private entities should not be held to the same high standard of protection as federal agencies should in taking action that might harm listed species. By adding in the "appreciable" threshold, the Services are improperly raising the level of permissible harm to critical habitat in a manner contrary to the intent of Congress.

Second, the "appreciably" threshold proposed by the Services remains to a large extent vague and meaningless. The Services propose that "appreciably diminish" refer to situations where the Services "can recognize or grasp the quality, significance, magnitude, or worth of the diminishment" or where the Services can "appreciate the difference it will have to the recovery of the listed species." [79 Fed. Reg. 27060 at 27063 (May 12, 2014).] This begs the question of what it means to "recognize," "grasp," or "appreciate" a diminishment of critical habitat. None of these inquiries are science-based, and will render most Section 7 consultations ad hoc and arbitrary as to when an action trips these thresholds. The "appreciably" threshold should be replaced with a clear standard that considers all non-trivial impacts to critical habitat during the consultation process. Doing so would not necessarily stop more projects from being approved, but instead would ensure that all federal actions that harm critical habitat are appropriately mitigated and addressed.

Finally, the Services propose that they will consider whether actions "appreciably diminish" critical habitat based on the effect to the conservation value of the designated critical habitat as a whole, rather than to the action area alone. This default rule neuters any remaining value that the Section 7 prohibition on critical habitat represents. If, for example, an endangered species has 50,000 acres of designated critical habitat, it will almost never be the case that any action adversely modifying one, or ten, or 100 acres of critical habitat will "appreciably diminish" the conservation value of the entire designation such that it can be "grasped" by the Services. Over time however, these cumulative small harms will have serious, negative implications for the recovery of species. While the Services may claim that they will consider these cumulative impacts, the Government Accountability Office found as recently as 2009 that the Fish and Wildlife Service almost universally lacks the ability to track take and adverse modification of critical habitat authorized under Section 7 of the ESA. [Government Accountability Office. 2009. THE U.S. FISH AND WILDLIFE SERVICE HAS INCOMPLETE INFORMATION ABOUT EFFECTS ON LISTED SPECIES FROM SECTION 7 CONSULTATIONS, Report #: GAO-09-550.]

As such, the proposal's approach for analyzing adverse modifications to critical habitat only as they relate to the entire designation lacks any scientific justification and will likely undermine the recovery of listed species. The draft proposal appears designed to avoid making tough calls about the impact of projects on critical habitat. We urge the Services to replace the "appreciably diminish" threshold with a clear standard that considers all non-trivial impacts to critical habitat during the consultation process.

Brett Hartl, CBD; Ya-Wei Li, DoW et al. October 9, 2014 letter to Interior Secretary Jewell.

Let Fire and Other Natural Processes Do the Ecological Work, Rather Than Rely on Commercial Logging for Fuel Reduction

We are concerned that projects like this are based on a false sense of control over nature when in reality fuel reduction has a low probability of encountering fire and has a modest/marginal effect on fire behavior, and wildfires continue to burn with a characteristic mix of low, moderate, and severe effects. The purpose and need for this project should be adjusted accordingly and the agency should consider alternatives that are based on working with, instead of against, natural processes.

The agencies are moving across the landscape often using commercial logging as a tool to aggressively manage fuels and reducing stand density which causes significant cumulative impacts on soil, water, wildlife habitat, carbon storage, and other values. These public resources are now exposed to the unprecedented compound effects of both logging and fire. The agency thinks it has found great alignment between its desire for timber production, risk reduction, and other restoration goals, but this view is just too convenient. It requires constant validation and reassessment. The view that everything aligns may be hiding significant trade-offs and causing the agency to overlook other viable options, such as decreasing reliance on logging and increasing reliance on fire as tools to achieve more optimal forest management outcomes. The accumulation of evidence does not support logging for fuel reduction as a sound strategy to manage fuel and fire.

- Most fires are climate driven, rather than fuel driven. The warming climate is likely to make this effect even more pronounced. Schoennagel et al 2017. Adapt to more wildfire in western North American forests as climate changes. PNAS 2017; published ahead of print April 17, 2017. www.pnas.org/cgi/doi/10.1073/pnas.1617464114; https://headwaterseconomics.org/wp-content/uploads/Adapt_To_More_Wildfire.pdf; Odion, D.C. et al 2014. Examining Historical and Current Mixed-Severity Fire Regimes in Ponderosa Pine and Mixed-Conifer Forests of Western North America. PLOS One. February 2014 | Volume 9 | Issue 2 http://www.californiachaparral.org/images/Odion_et_al_Historical_Current_Fire_Regimes_mixed_conifer_2014.pdf; See also, Alisa Keyser and Anthony Westerling, 2017. Climate drives inter-annual variability in probability of high severity fire occurrence in the western United States, Environmental Research Letters. Accepted Manuscript online 4 April 2017 https://doi.org/10.1088/1748-9326/aa6b10.
- There is not a significant trend toward more severe fires in the west.
    - Schwind, B. (compiler). 2008. MTBS: Monitoring Trends in Burn Severity: Report on the PNW & PSW Fires — 1984 to 2005. https://web.archive.org/web/20130214220819/http://www.mtbs.gov/reports/MTBS_pnw-psw_final.pdf ("MTBS data does not support the assumption that wildfires [in the PNW] are burning more severely in recent years. ... The majority of area burned falls within the unburned to low severity range, with relatively low annual variation in these severity classes. The high and moderate severity classes show higher relative

variation between years, suggesting that these classes may be most influenced by variation in climate, weather, and seasonal fuel conditions.")

- Vaillant & Reinhardt 2017. An Evaluation of the Forest Service Hazardous Fuels Treatment Program—Are We Treating Enough to Promote Resiliency or Reduce Hazard? J. For. 115(4):300 –308. July 2017. https://doi.org/10.5849/jof.16-067. https://www.fs.fed.us/pnw/pubs/journals/pnw_2017_vaillant001.pdf (Nationwide, only 11% of fires burn uncharacteristically.)
- Law, B.E., Waring, R.H. 2015. Review and synthesis - Carbon implications of current and future effects of drought, fire and management on Pacific Northwest forests. Forest Ecology and Management 355 (2015) 4–14. http://terraweb.forestry.oregonstate.edu/pubs/law.fmec.2015.pdf (This study reported no significant trend in area burned, number of fires, or fire severity for the state of Oregon.)
- Ray Davis et al 2015. RMP Revisions for Western Oregon BLM DEIS. Appendix D – Modeling Wildfires and Fire Severity. http://www.blm.gov/or/plans/rmpswesternoregon/files/draft/RMP_EIS_Volume3_appd.pdf. ("… examined the MTBS data for any obvious temporal trends in wildfire severity [within the range of the spotted owl], but did not detect a strong signal (Figure D-6). Over the course of 25 years, there appears to be a slight increase in the percentage of area burned by low and moderate severity wildfire, and a slight decrease in the percent of area burned in high severity wildfire, although these trends are not statistically significant. …")
- Alisa Keyser and Anthony Westerling, 2017. Climate drives inter-annual variability in probability of high severity fire occurrence in the western United States, Environmental Research Letters. Accepted Manuscript online 4 April 2017 https://doi.org/10.1088/1748-9326/aa6b10. ("We tested trends for WUS [western United States], each state, and each month. We found no significant trend in WUS high severity fire occurrence over 1984-2014, except for Colorado (table S1). While some studies have shown increasing fire season length, we saw no significant increase in high severity fire occurrence by month, May through October (figure S1). We found no correlation between fraction of high severity fire and total fire size, meaning increasing large fires does not necessarily increase fractional high severity fire area.")
- Brendan P. Murphy, Larissa L. Yocom, Patrick Belmont. 2018. Beyond the 1984 perspective: narrow focus on modern wildfire trends underestimates future risks to water security. Earth's Future, 2018; DOI: 10.1029/ 2018EF001006 https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2018EF001006 ("Compiling several datasets, we illustrate a comprehensive history of western wildfire, demonstrate that the majority of western settlement occurred during an artificially and anomalously low period of wildfire in the 20th century, ... A crucial first step toward realigning public perspectives will require scientists and journalists to present recent increases in wildfire area within the context and scale of longerterm trends. ... A review of Science, Nature, and PNAS reveals that 77% of wildfire-related articles published about the western U.S. since 2000 (n=52) only address fire trends from the past few decades. In many of these studies, as well as in principal wildfire databases (Eidenshink et al., 2007; NIFC, 2017), ca. 1984 is frequently the first year presented, because this marks the beginning of consistent, satellite-derived records (Short, 2015). Wildfire area has rapidly increased since 1984, as ecosystems realize their

potential to burn in an era of lengthening fire seasons and warming temperatures (Abatzoglou & Williams, 2016). However, this "1984 perspective" of wildfire is problematic. First and foremost, the 1980s represent the end of an anomalously low period for wildfire during the mid-20th century, and western U.S. landscapes remain well below historical wildfire activity (Barrett, et al., 1997; Leenhouts, 1998; Stephens et al., 2007; Littell et al., 2009; Swetnam et al., 2016). ... Historical reconstructions of annual area burned demonstrate that wildfire area in the pre-settlement western U.S. was many times greater than the supposed 'record highs' of today (Barrett, et al., 1997; Leenhouts, 1998; Stephens et al., 2007) (Fig. 1A&C). Borne out by hundreds of fire-history studies, research consistently shows that dry western forests frequently burned by wildfire over the past few centuries (Falk et al., 2010). Although wildfire activity naturally oscillates over millennial timescales (Marlon et al., 2012), area burned across the West began to rapidly decline in the late 19th century with the introduction of railroads and livestock (Swetnam et al., 2016). This was especially true in dry forest ecosystems, where livestock ate the fine fuel necessary to carry widespread surface fires. By the mid-20th century (ca. 1950s to mid-1980s), the area burning annually across all western ecosystems had plummeted from 7-18 Mha to less than 0.5 Mha due to fire suppression activities (Leenhouts, 1998; Littell et al., 2009) (Figure 1A). This West-wide decline in area burned is corroborated by subregional records (Figure 1C) and is consistent with the 20th century "fire deficit" observed in fire scar and charcoal influx records Marlon et al., 2012). ... The annual area burned, as well as burn severity, are projected to continue increasing across the western U.S. through the 21st century due to climate change and, in some ecosystems, excess fuel loading from fire suppression (Brown et al., 2004; Westerling et al., 2011; Hawbaker & Zhu, 2012; Abatzoglou & Williams, 2016; Abatzoglou et al., 2017).")

- Baker, W. L. 2015. Are high-severity fires burning at much higher rates recently than historically in dry-forest landscapes of the Western USA? PLoS ONE 10(9): e0136147;
- Collins, B.M. et al. 2009. Interactions among wildland fires in a long-established Sierra Nevada natural fire area. Ecosystems 12:114–128;
- Dillon, J.K. et al. 2011, Both topography and climate affected forest and woodland burn severity in two regions of the western US, 1984 to 2006. Ecosphere 2: Article 130;
- Hanson, C. T. and D.C. Odion, 2014. "Is fire severity increasing in the Sierra Nevada, California, USA? International Journal of Wildland Fire 23: 1–8;
- Hanson, C.T. and D.C. Odion, 2015. Sierra Nevada fire severity conclusions are robust to further analysis: a reply to Safford et al. International Journal of Wildland Fire 24: 294-295;
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    - Picotte et al. 2016. 1984-2010 Trends in fire burn severity and area for the coterminous US. International Journal of Wildland Fire 25: 413-420;
    - Schwind, B. 2008. Monitoring trends in burn severity: report on the Pacific Northwest and Pacific Southwest fires (1984 to 2005). US Geological Survey.
- There is a relatively low probability that fuel treatments will interact with wildfire before fuels regrow and render the fuel reduction effort ineffective. "A recent study conducted by researchers at the University of Montana found that only about 7 percent of fuel-reduction treatment areas in the entire United States were subsequently hit by wildfires since 1999. … If someone had the magical ability to predict, within the past decade, that a major fire was going to strike that particular portion of the 240,000-acre Scapegoat Wilderness, then thinning and logging theoretically could have helped. But it doesn't work that way, and fires are sparked in random places by lightning and humans, and they are pushed by erratic winds and weather. … According to Tania Schoennagel, a forest landscape ecologist and fire researcher at the University of Colorado, … 'it's little bit of a crapshoot probability game whether the treatment you put in is going to encounter wildfire in the 10 to 15 years it remains effective in reducing fire severity. Simply because forests in the West are so vast, the chance of burning in a place we've pre-treated is so low. It's not a very effective lever. We don't know where fires are going to happen.'" David Erickson (2017). Experts: More logging and thinning to battle wildfires might just burn taxpayer dollars. CREDIT: MISSOULIAN.COM. Oct 1, 2017. http://www.america.easybranches.com/montana/Experts--More-logging-and-thinning-to-battle-wildfires-might-just-burn-taxpayer-dollars-152776 *citing* Kevin Barnett, Sean A. Parks, Carol Miller, and Helen T. Naughton. 2016. Beyond Fuel Treatment Effectiveness: Characterizing Interactions between Fire and Treatments in the US. Forests [open access] 2016, 7, 237; doi:10.3390/f7100237. http://www.mdpi.com/1999-4907/7/10/237. See also, William L. Baker, Jonathan J. Rhodes. 2008. Fire Probability, Fuel Treatment Effectiveness and Ecological Tradeoffs in Western U.S. Public Forests. pp.1-7 (7). The Open Forest Science Journal, Volume 1. 2008. http://api.ning.com/files/1kp0vDW*F1cqOeO4-GdXE1AHOATghmIAN2x9qLpH3aA_/FireandFuelTreatments.pdf; "According to a recent analysis, annually less than one percent of U.S. Forest Service fuel reduction treatments in forested areas subsequently burned, on average. From 2000 to 2015, almost 17 million acres of federal land were treated for fuels reduction, equating to approximately four percent of U.S. Forest Service and Bureau of Land Management lands. During the same time period, more than 93 million acres burned. The odds of putting fuel treatments in the wrong place are extremely high." Pohl, Kelly 2019. "For communities, land use planning is more effective than logging on federal lands to reduce future wildfire disasters." https://headwaterseconomics.org/wildfire/solutions/land-use-planning-is-more-effective/.
- The effects of fuel reduction are modest. Even extensive fuel reduction reduces the extent of wildfire by less than 10 percent. See M. A. Cochrane, C. J. Moran, M. C. Wimberly, A. D. Baer, M. A. Finney, K. L. Beckendorf, J. Eidenshink, and Z. Zhu. 2012. Estimation of wildfire size and risk changes due to fuels treatments. International Journal of Wildland Fire. http://dx.doi.org/10.1071/WF11079. http://www.publish.csiro.au/?act=view_file&file_id=WF11079.pdf. Andrew Larson, a forest ecologist from the University of Montana said

> "Even after you go and thin a forest, when it's dry like it is now, it's still going to carry a fire, it's still going to generate smoke. So, in terms of day to day life, the experience we have during the fire season, we need to not get our hopes up," Larson says. "You can anticipate more smoke. Even if we were to double, triple, increase the amount of area logged or thinned by a factor of ten or 20, we're still going have smoke, we're not going to stop the fires. We may change how they burn, and that's an important outcome, it's something that a lot of my research is directed at. But we need to make sure people don't get their hopes up and expect something that the forestry profession, that managers in the Forest Service, the Department of Interior, can't deliver on."

ERIC WHITNEY 2017. Forest Ecologist Comments On Senator Daines' Fire Call. Montana Public Radio. Sept 14, 2017. http://mtpr.org/post/forest-ecologist-comments-senator-daines-fire-call. Also, Hurteau et al (2019) found that "fuel availability and flammability only reduced the cumulative area burned in the Sierra by about 7.5 percent over the course of the century ... because vegetation re-growth
happens with sufcient speed that the fuel limitation efects from fre are short-lived." Matthew D. Hurteau, Shuang Liang, A. LeRoy Westerling & Christine Wiedinmyer 2019. Vegetation-fire feedback reduces projected area burned under climate change. Scientific Reports, volume 9, Article number: 2838 (2019), https://www.nature.com/articles/s41598-019-39284-1; https://doi.org/10.1038/s41598-019-39284-1; https://news.ucmerced.edu/news/2019/scientists-simulate-forest-fire-dynamics-understand-area-burn-future-wildfires

- Commercial logging will often make fire hazard worse, not better. Reducing the forest canopy will make the stand hotter, drier, and windier, produce more activity fuels, and stimulate the growth of ladder fuels. Professor Char Miller said "… decades of data show that intense logging creates more destructive fires than the ones that burn through roadless areas, parkland and wilderness." Char Miller. 2017. Op-Ed: What the Trump administration doesn't understand about wildfires. LA Times. Oct 1, 2017. http://www.latimes.com/opinion/op-ed/la-oe-miller-zinke-fire-memo-20171001-story.html. See also, Jain, Theresa B.; Battaglia, Mike A.; Han, Han-Sup; Graham, Russell T.; Keyes, Christopher R.; Fried, Jeremy S.; Sandquist, Jonathan E. 2012. A comprehensive guide to fuel management practices for dry mixed conifer forests in the northwestern United States. USDA Forest Service Gen. Tech. Rep. RMRS-GTR-292. 2012 http://www.firescience.gov/projects/09-2-01-16/project/09-2-01-16_09-2-01-16_rmrs_gtr292web.pdf. A meta-analysi of the effects of partial cutting showed that understory growth was stimulated in all cases. D. Zhou, S. Q. Zhao, S. Liu, and J. Oeding. 2013. A meta-analysis on the impacts of partial cutting on forest structure and carbon storage. Biogeosciences, 10, 3691–3703, 2013. https://www.biogeosciences.net/10/3691/2013/bg-10-3691-2013.pdf. ("Understory C was stimulated significantly by partial cutting in all of the studies. This stimulation can be mostly attributed to an increase in the availability of light, water, and nutrients to the understory because of tree removal (Aussenac, 2000; Kleintjes et al., 2004; Deal, 2007)")Removing commercial sized logs as part of fuel reduction degrades habitat while doing little to modify fire behavior. If conducted at large scales, the effects of commercial logging for fuel reduction will be socially and ecologically unacceptable. Lehmkuhl, John; Gaines, William; Peterson, Dave W.; Bailey, John; Youngblood, Andrew, tech. eds. 2015. Silviculture and monitoring guidelines for integrating restoration of dry mixed-conifer forest and spotted owl habitat management in the eastern Cascade Range. Gen. Tech. Rep. PNW-GTR-915. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 158 p. http://www.fs.fed.us/pnw/pubs/pnw_gtr915.pdf. ("Tradeoffs between fire resistance and NSO habitat quality are real. Our results demonstrate that balancing the goals of increasing fire resilience while maintaining habitat function, especially nesting and roosting, for the NSO in the same individual stand is a difficult, if not an impossible, task. Even lighter thinning treatments typically reduce canopy cover below 40 percent. The reality is that nesting and roosting NSO habitat is by definition very susceptible to high-severity fire; owl habitat value and fire risk are in direct conflict on any given acre. …"). Montana Public Radio reported on Senatro Daines statement that "'radical environmentalists' would try to stop efforts to remove dead trees from Montana forests. [Ecologist Andrew Larson said] "That's an attitude that I'm always kind of disappointed to encounter," Larson said, "because a healthy forest has dead trees and dead wood. The snags — standing dead trees — and dead logs are some of the most important habitat features for biodiversity. You can't have an intact, healthy wildlife community without dead wood in your forest." ERIC WHITNEY 2017. Forest Ecologist Comments On Senator Daines' Fire Call. Montana Public Radio. Sept 14, 2017. http://mtpr.org/post/forest-ecologist-comments-senator-daines-fire-call;

- Only a small fraction of needed density reduction can support an economically viable timber sale. See Rainville, Robert; White, Rachel; Barbour, Jamie, tech. eds. 2008. Assessment of timber availability from forest restoration within the Blue Mountains of Oregon. Gen. Tech. Rep. PNW-GTR-752. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 65 p. http://www.fs.fed.us/pnw/pubs/pnw_gtr752.pdf ("Hoping to boost their economies and also restore these forests, local leaders are interested in the economic value of timber that might be available from thinning treatments on these lands. … [W]e found that on lands where active forestry is allowable, thinning of most densely stocked stands would not be economically viable. … In the 46 percent of the three Blue Mountains national forests that is forested, thinning with timber removal is an unlikely treatment method. This does not mean that other vegetative management options (prescribed fire, wildland fire use, or thinning without commercial timber removal) could not be used to reduce fire hazard, but it is doubtful that these areas would produce much commercial timber. … Commercial thinning would only be possible where the value of the timber harvested exceeds the cost of the harvesting, hauling, road maintenance, and contractual requirements (i.e., a positive net revenue exists). Because most simulated thinnings harvested low volumes of small trees, commercial removal was possible on only 39,900 (± 4,600) acres, or less than 10 percent of the densely stocked acres (table 4-8). … … even when considered under the most favorable of assumptions, most densely stocked stands would not be treatable without significant investments.")
- The agencies are failing to treat the areas of highest hazard and choosing instead to treat areas that produce profitable timber sales. Vaillant & Reinhardt 2017. An Evaluation of the Forest Service Hazardous Fuels Treatment Program—Are We Treating Enough to Promote Resiliency or Reduce Hazard? J. For. 115(4):300 –308. July 2017. https://doi.org/10.5849/jof.16-067. https://www.fs.fed.us/pnw/pubs/journals/pnw_2017_vaillant001.pdf. ("[W]e evaluated the [nationwide] extent of fuel treatments and wildfire occurrence within lands managed by the National Forest System (NFS) between 2008 and 2012 … The very high hazard class had the lowest treatment percentage and the highest incidence of uncharacteristically high-severity wildfire out of all the hazard classes. … Areas of very low

hazard often are favored for treatment because they are less complex to plan and implement, are more economical to treat, … [T]reatments may be placed where they can accomplish multiple objectives, including production of wood products. This may result in selection of locations that are less important for hazard mitigation.")

- Land use planning is more effective than logging to reduce wildfire risk. Pohl, Kelly 2019. "For communities, land use planning is more effective than logging on federal lands to reduce future wildfire disasters." https://headwaterseconomics.org/wildfire/solutions/land-use-planning-is-more-effective/. ("[W]e have the knowledge and tools to reduce risk posed by homes in wildfire-prone areas. ... [T]here are many land use planning tools available that can mean the difference between home survival and loss."). The fire threat to communities is caused by, and may be best addressed by, land use practices, not forest fuels. Forest fuels policy needs to recognize that structures themselves represent hazardous fuels that can carry fire from structure-to-structure, or from structure-to-forest. There are already too many homes in the wildland urban interface, and more are being built every day. Radeloff, Helmers, Kramer et al 2017. Rapid growth of the US wildland-urban interface raises wildfire risk. Proceedings of the National Academy of Sciences. Mar 2018, 2017. https://www.pnas.org/cgi/doi/10.1073/pnas.1718850115. ("Abstract: … Here we report that the WUI in the United States grew rapidly from 1990 to 2010 in terms of both number of new houses (from 30.8 to 43.4 million; 41% growth) and land area (from 581,000 to 770,000 km2; 33% growth), making it the fastest-growing land use type in the conterminous United States. The vast majority of new WUI areas were the result of new housing (97%), not related to an increase in wildland vegetation. Within the perimeter of recent wildfires (1990–2015), there were 286,000 houses in 2010, compared with 177,000 in 1990. Furthermore, WUI growth often results in more wildfire ignitions, putting more lives and houses at risk. Wildfire problems will not abate if recent housing growth trends continue."). This also shows that people are quite willing to tolerate fire hazard in order to enjoy the quality of life associated with living near the forest.
- Unlogged areas provide many benefits such as wildlife cover, snag & wood recruitment, carbon storage, soil/watershed quality, microclimate buffering, etc. Forests are naturally adaptive and natural processes will accomplish many of the benefits attributed to thinning. "Counter to many regional studies, our results indicated that treated and long-unaltered, untreated areas may be moving in a similar direction. Treated and untreated areas experienced declines in tree density, increases in the size of the average individual, and losses of surface fuels in most size classes. The number of large trees increased in untreated areas, but decreased in treated areas. Our results suggested that untreated areas may be naturally recovering from the large disturbances associated with resource extraction and development in the late 1800s, and that natural recovery processes, including self thinning, are taking hold. ... In a study of forest restoration need across eastern Washington and Oregon, over 25% of required restoration could be achieved through transition to later stages of forest stand development through successional processes as western landscapes recover from widespread historic degradation (Haugo et al., 2015)." Zachmann, L. J., D. W. Shaw, and B. G. Dickson. 2018. Prescribed fire and natural recovery produce similar long-term patterns of change in forest structure in the Lake Tahoe basin, California. Forest Ecology and Management 409:276–287. http://www.csp-inc.org/wp-content/uploads/2017/11/Zachmann_et_al_2017.pdf

- The 2017 Fuels Report for the 130,000 acre East Hills Project on this Fremont-Winema NF admits that wildfires are expected to have beneficial effects even under the no action alternative - "Overall expected value of fire effects is moderately beneficial. This assumes that fires burn throughout the range of conditions – actual current practice is to suppress fires that are most likely to be beneficial." https://www.fs.usda.gov/nfs/11558/www/nepa/101283_FSPLT3_4264365.pdf. This would indicate a need to modify fire suppression practices and work *with* fire when weather conditions are favorable.

Considering all of this, forest managers need to recognize that they cannot log their way out of the fuel predicament they are in. Forest managers will eventually come to realize that the vast majority of the ecological work will be accomplished by wild and prescribed fire.

Oregon Wild supports the objective of preparing the forest for wildfire, but this does not mean that extensive commercial logging is required. Preparing for fire can often be done best by doing non-commercial pre-treatment followed by prescribed fire at the appropriate time, when the weather and fuels are relatively cool and moist. Fire is preferable because it has a lighter ecological footprint on soil, water, and large wood habitat.

Basal Area Retention

Basal Area retention is an important ecological consideration that must be disclosed *quantitatively* in the NEPA analysis. The NEPA analysis should consider alternative levels of basal area retention that resolve trade-offs in different ways. The NEPA document should disclose how recommended basal area retention levels will provide assurance that enough trees are being retained to meet ecological needs for live and dead trees now and in the future.

Where there are lots of small trees we recommend variable density thinning to 60-80 sq ft/acre basal area, retaining the largest trees that will become the next generation of old growth. Since larger trees have a higher ratio of basal area to leaf area, sites with abundant large trees can sustain higher basal areas, and we recommend retaining 100-140+ sq ft/acre.

Basal area retention should be variable but not be too low in any one unit. Enough trees need to be retained to retain and recruit large and old trees and snags now and in the future. Basal area targets should be adjusted higher to account for the following actors:

- Prescribed basal area retention should be weighted to accommodate relatively greater retention in stands with large trees and desirable clumps of trees that contribute to LOS structural conditions.
- All things being equal, large and old trees are more sustainable and resilient than small trees, so where large and old trees are abundant, the site can sustain higher basal area and the mature and old trees do not need to be thinned.

- Retention patches should be excluded from the basal area calculation. Basal area should not be averaged across the stand, but rather across the treated portion of the stand. We recommended 3-4 clumps per acre of 2-10 individual trees as well as the skips to emulate natural historic stand structures.
- Basal area can be higher in riparian areas, area with higher water table, north slopes, etc...

The agency should avoid reducing stand density lower than is appropriate to meet the full suite of ecological objectives, including wildlife cover, perpetuating mortality processes that create and sustain valuable habitat features, etc.

We are concerned that the agencies' stocking guides were created and intended to be used as a tool to avoid mortality which is clearly inconsistent with ecosystem management. ("To preclude serious tree mortality from mountain pine beetle, western dwarf mistletoe and perhaps western pine beetle, stand densities should be maintained below the upper limit of the management zone" Powell 1999, https://fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev7_016034.pdf) Healthy forests require dead trees, sometimes in abundance, in order to meet the needs of diverse wildlife and provide full suite of ecosystem functions. Rose, C.L., Marcot, B.G., Mellen, T.K., Ohmann, J.L., Waddell, K.L., Lindely, D.L., and B. Schrieber. 2001. Decaying Wood in Pacific Northwest Forests: Concepts and Tools for Habitat Management, Chapter 24 in Wildlife-Habitat Relationships in Oregon and Washington (Johnson, D. H. and T. A. O'Neil. OSU Press. 2001) http://web.archive.org/web/20060708035905/http://www.nwhi.org/inc/data/GISdata/docs/chapter24.pdf

A comprehensive restoration approach requires focusing not just on live trees, but also on the full suite of ecological processes including density dependent mortality processes that create and recruit snags and dead trees as a valuable feature of eastside forests. We urge the agency not to manage for tree vigor and minimum stocking levels because it will not provide enough green trees for recruitment of snags through time. This is a critical issue given that the current standards for snag habitat are outdated and fail to provide adequate levels of snags and dead wood, and adequate levels of green trees needed to recruit those snags through time.

Cutting basal area down to 30-40 ft^2/acre is too low. We urge the agency to retain at least 60-120 ft^2/acre of basal area. 30-40 ft2/acre might be OK in small patches within units as part of a variable prescription, but the average over a unit must be much higher than that in order to ensure adequate cover for wildlife, and adequate dead wood recruitment through time.

Weak Relationship Between Stand Density and Forest Health or Resilience

> Pre-fire nesting/roosting habitat had lower probability of burning at moderate or high severity compared to other forest types under high burning conditions. Our results indicate that northern spotted owl habitat can buffer the negative effects of climate

change by enhancing biodiversity and resistance to high-severity fires, which are predicted to increase in frequency and extent with climate change. Within this region, protecting large blocks of old forests could be an integral component of management plans that successfully maintain variability of forests in this mixed-ownership and mixedseverity fire regime landscape and enhance conservation of many species.

Lesmeister, D. B., S. G. Sovern, R. J. Davis, D. M. Bell, M. J. Gregory, and J. C. Vogeler. 2019. Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere 10(4):e02696. 10.1002/ecs2.2696. https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/ecs2.2696.

The relationship between stand density and mortality may be intuitively appealing but is not well-supported by the evidence. Recent comments from the Center for Biological Diversity to the California Department of Forestry explained --

> A study in the Douglas fir forests of northeastern Washington found that competition [i.e., higher density] did not affect tree responses to extreme drought. Importantly, trees with more competition from neighbors appeared to have higher drought resistance (i.e., a significantly higher proportion of sapwood area in latewood, which is a trait associated with drought resistance). The authors suggested that "a tree's ability to cope with environmental variability is driven not just by the proximate effects of neighbours on resource availability, but also by phenotypic plasticity and long-term adaptations to competitive stress."
>
> A study that directly investigated the lack of fire on the physiological status of oldgrowth ponderosa pine trees in unlogged forests in Idaho found that, contrary to predictions, oldgrowth trees in stands that were unburned for at least 70 years showed no significant differences in multiple stress indicators compared to non-fire-suppressed stands, indicating that these trees may be "more resilient to increased stand density associated with the lack of fire than previously thought."

Center for Biological Diversity et al., March 17, 2017 comments on the California Forest Carbon Plan (January 20, 2017 Draft). http://www.biologicaldiversity.org/campaigns/debunking_the_biomass_myth/pdfs/Forest_Carbon_Plan_Comments.pdf *citing* Carnwath, G.C. and C.R. Nelson. 2016. The effect of competition on response to drought and interannual climate variability of a dominant conifer tree of western North America. Journal of Ecology 104: 1421-1431, and Keeling, E.G. et al. 2011. Lack of fire has limited physiological impact on old-growth ponderosa pine in dry montane forests of north-central Idaho. Ecological Applications 21: 3227-3237.

The CBD comments cited above provided several useful excerpts from the literature--

> Recent studies of epidemic forest mortality events have not found stand density to be a significant contributor to tree death and instead, have attributed forest declines to the effects of top-down drivers such as moisture stress and drought, and associated spread and

proliferation of bark beetle populations (Ganey and Vojta, 2011; Lines et al., 2010; Sánchez-Martínez and Wagner, 2002; van Mantgem and Stephenson, 2007). During episodic forest mortality events, the role of site environment, spatial proximity and landscape configuration can become more important than stand characteristics for predicting mortality patterns (MacQuarrie and Cooke, 2011; Powers et al., 1999; Simard et al., 2012). Differences in the importance of tree vigor and spatial aggregation may help explain why hazard ratings based on stand characteristics have little predictive power when applied to landscapes (Logan et al., 1998; Nelson et al., 2007). A comprehensive understanding of the role of density dependence during both epidemic and non-epidemic (‘‘background”) mortality periods remains elusive (Stamp, 2003).

Van Gunst, K.J. et al. 2016. Do denser forests have greater risk of tree mortality: a remote sensing analysis of density-dependent forest mortality. Forest Ecology and Management 359: 19-32.

Recent findings that stands with higher density do not necessarily exhibit greater physiological stress (Keeling, Sala & DeLuca 2011) or experience lower tree mortality in extreme drought events (e.g. Floyd et al. 2009; van Mantgem et al. 2009; Ganey & Vojita 2011) lend support to this idea but other studies have shown the opposite relationship between density and mortality (Negron et al. 2009; Kane & Kolb 2014) or that this relationship is inconsistent and context dependent (Meddens et al. 2015; Van Gunst et al. 2016).

Carnwath, G.C. and C.R. Nelson. 2016. The effect of competition on response to drought and interannual climate variability of a dominant conifer tree of western North America. Journal of Ecology 104: 1421-1431.

However, the available evidence suggests that density-dependent mortality is not as typical of old and large tree subpopulations in conifer forests (Acker et al., 1996; Das et al., 2011; Aakala et al., 2012; Silver et al., 2013; Larson et al., 2015) as it is in the smaller size classes (Das et al., 2011; Lutz et al., 2014).

Clyatt, K.A. et al. 2016. Historical spatial patterns and contemporary tree mortality in dry mixed-conifer forests. Forest Ecology and Management 361: 23-37.

New evidence indicates that forests continue to grow vigorously even when they have some signs indicating otherwise. Allan Baumann (2018) looked closely at the well-researched old growth stand on the Umpqua National Forest and found that many trees with poor form and fungal infections were still growing well, so logging to increase tree vigor may not be needed.

Conventional young-growth thinking is that key crown structural form is important for adequate tree development; e.g. having crown ratios greater than 40% for Douglas-fir and not having a one-sided form. In testing these hypothesis against the Lynx old-growth some interesting results were found. These might influence future forest management for improving the resilience, health and sustainability of these valued genetic-legacy trees of the forest.

An in-depth look at one-sided crown trees found that while 24% did have poor growth rates, 76% had moderate or fast growth rates. Testing trees with less than 20% crown form found only 13% growing poorly, while 87% grew moderate-fast over the 40-year period. Testing trees with both poor crowns and one-sided structure, found that 23% had poor growth and 77% had moderate-fast growth rates.

Further analysis was done on trees with visible conk indicators. Fifty-one (51) trees with Phellinus pini were measured and while 26% had poor growth rates, 74% had moderate-fast growth rates. Six (6) trees with Phaeolus Schweinitzii were measured and 33% had poor growth rates and 66% were unexpectedly growing moderate-fast. Implications for this additional growth are not normally considered.

Baumann, A. 2018. Lynx #1 White paper.

Sohn et al (2016) conducted a meta-analysis which showed that thinning conifers does have an effect on trees' resistance and resilience to drought, but that effect is not large and diminishes over time:

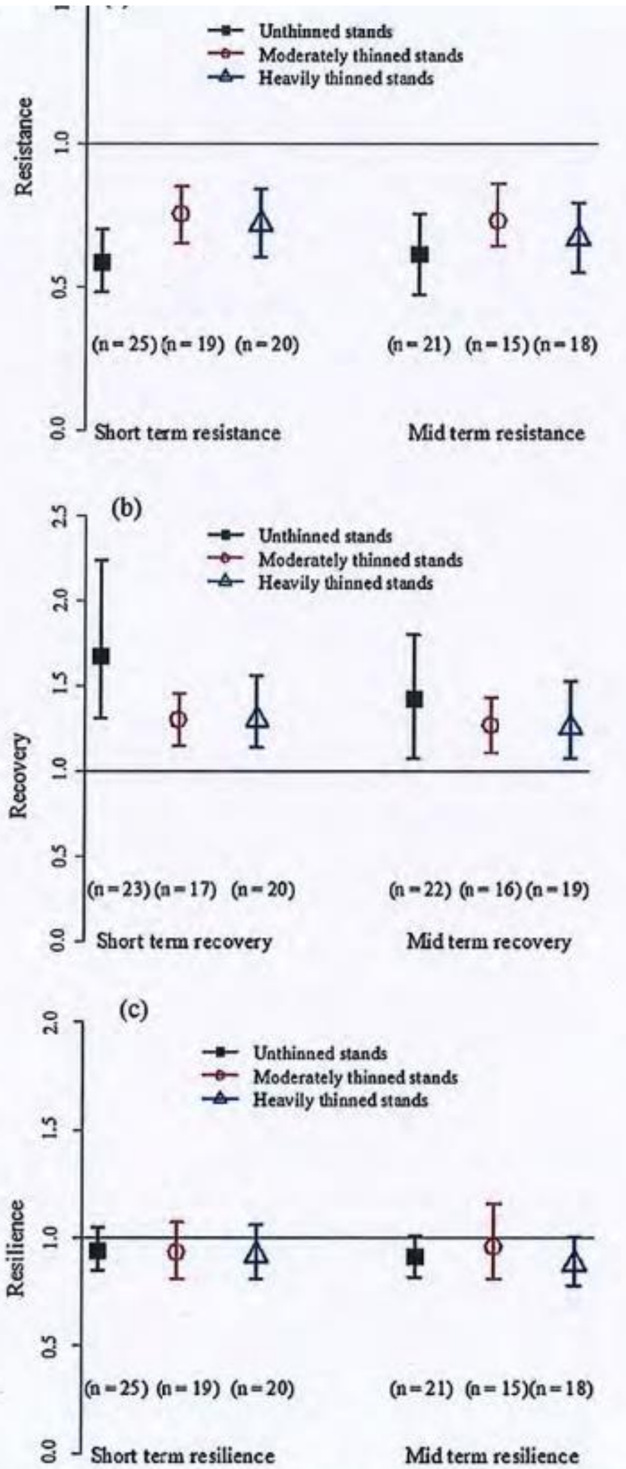


Fig. 3. (a–c) Global cumulative effect sizes as well as associated confidence intervals for the resistance (a), recovery (b), and resilience (c) in relation to drought among differently thinned stands. For each of the 3 *Lloret-indices*, we calculated (left) a short-term index using the value referring to 1 year before (for resistance and resilience) or after the drought (recovery and resilience) and (right) a medium-term index using the mean of the 3 years before or after the drought event (see Lloret et al., 2011; Kohler et al., 2010). Values of 1 mean for resistance that no growth reduction has taken place, at 0.5 a 50% reduction occurred. For recovery, a value of 1 means that growth after drought stayed at the level of the drought year. For resilience, a value of 1 indicates that growth after the drought returned to the pre-drought level. Sample size was n = 15–25.

Sohn, J. A., S. Saha, and J. Bauhus. 2016. Potential of forest thinning to mitigate drought stress: a meta-analysis. Forest Ecology and Management 380:261–273. https://www.researchgate.net/profile/Somidh_Saha/publication/308097759_Potential_of_forest_thinning_to_mitigate_drought_stress_A_meta-analysis/links/59cc0becaca272bb050c64ea/Potential-of-forest-thinning-to-mitigate-drought-stress-A-meta-analysis.pdf?origin=publication_detail. This analysis also showed that heavy thinning was less effective on more arid sites. Thinning in water-limited sites that exposes individual large trees to more sunlight may actually increase certain stress factors, causing "greater vulnerability to hydraulic stress and to higher radiation and evaporative demand of the more exposed crowns" when compared to smaller trees in crowded stands.

Well-intentioned logging has impacts that make ecosystems less resilient to climate change. For instance, roads and soil degradation make watershed less resilient to the expected effects of the amplified hydrologic cycle; reduction of complex forest structure and dense forest conditions makes certain species populations less resilient to climate change, including species associated with relatively dense forests and species associated with snags and dead wood. These species are already stressed by the cumulative effects of non-federal land management and fragmentation caused by past and ongoing management on federal lands.

Also, "High overstory density can be resilient" when ladder fuel are absent and there is a gap between surface and canopy fuels. Terrie Jain (2009) Logic Paths for Approaching Restoration: A Scientist's Perspective, *from* Workshop: Restoring Westside Dry Forests - Planning and Analysis for Restoring Westside Cascade Dry Forest Ecosystems: A focus on Systems Dominated by Douglas-fir, Ponderosa Pine, Incense Cedar, and so on. May 28, 2009. http://ecoshare.info/projects/central-cascade-adaptive-management-partnership/workshops/restoring-westside-dry-forests/

A bet-hedging strategy should retain trees of all sizes and stands of various densities. "Removal of most small trees to reduce wildfire risk may compromise the bet-hedging resilience, provided by small trees and diverse tree sizes and species, against a broad array of unpredictable future disturbances." William L. Baker and Mark A. Williams. 2015. Bet-hedging dry-forest resilience to climate-change threats in the western USA based on historical forest structure. Front. Ecol. Evol., 13 January 2015 | doi: 10.3389/fevo.2014.00088.http://journal.frontiersin.org/Journal/10.3389/fevo.2014.00088/full

Retain and Restore Genetic Diversity of Trees

There are significant unacknowledged risks involved when humans decide which trees live and which trees die. Natural mortality from drought, insects, and fire have shaped the genetic make-up of the forest for millennia, favoring more fit individuals and increasing the resilience of forest stands. Logging is a novel cause of mortality that does not favor the fittest individuals. The agency must carefully consider the consequences of logging that decouples mortality from fitness, survival and resilience. This is especially important in light of climate change. Conserving genetic and phenotypic diversity is important for climate adaptation. Halofsky, J.E.; Peterson, D.L., eds. 2016. Climate change vulnerability and adaptation in the Blue Mountains. Gen. Tech. Rep. PNW-GTR-xxx. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. (Table 6.8e) http://adaptationpartners.org/bmap/docs/BMAP_final.pdf. Also, Matthew Reilly, 2018. Chapter 2: Climate, Disturbance, and Vulnerability to Vegetation Change in the Northwest Forest Plan Area. Northwest Forest Plan Science Synthesis – Science Forum | Tuesday, June 26, 2018 | Portland, Oregon. https://docs.wixstatic.com/ugd/8f8000_08456f0927cb4aa88b18f341b3c7c435.pdf. A strategy to conserve genetic diversity would do two things: First, protect all old trees that have survived previous climate extremes. These legacy trees have already shown their fitness for survival. Protecting such trees might involve careful actions to reduce competition and ladder fuels in the immediate vicinity of those legacy trees. Second, let natural processes determine which of the younger trees are most fit to survive. Genetic fitness is not obvious even to the trained forester. Logging might inadvertently let the least fit survive and kill the trees with the most fit genes.

The agency must recognize that natural mortality provides an important ecological function – that is, it promotes evolutionary adaptation which is critical right now in the face of climate change.

> [R]esearchers were surprised to find that the mortality of established trees considerably promotes the adaptation of forests to the changing environment. … Evolution is promoted by the mortality of established trees. The researchers assumed that demographic characteristics of the trees would have a notable impact on their adaptability. Tree species differ for example so that birch matures at a considerably younger age than pine, and birch seeds spread more effectively than pine seeds. However, the results showed that these differences had only minor impacts. Instead, the mortality of established trees played a large role in the evolutionary adaptation.

Northern forests do not benefit from lengthening growing season. UNIVERSITY OF HELSINKI. PUBLIC RELEASE: 12-JAN-2010. http://www.eurekalert.org/pub_releases/2010-01/uoh-nfd011210.php.

Importantly, for natural selection to occur, mortality must be caused by natural events like drought, insects, and fire, rather than through human choices about which trees will live and which will die.

Biologist Derek Lee points out that

> … logging schemes are the latest in a series of Forest Service attempts to chainsaw their way out of a perceived problem. However, forests in the western United States have evolved to naturally self-thin uncompetitive trees through forest fires, insects, or disease. Forest fires and other disturbances are natural elements of healthy, dynamic forest ecosystems, and have been for millennia. These processes cull the weak and make room for the continued growth and reproduction of stronger, climate-adapted trees. Remaining live trees are genetically adapted to survive the new climate conditions and their offspring are also more climate-adapted, resistant, and resilient than the trees that perished. Without genetic testing of every tree in the forest, indiscriminate thinning will remove many of the trees that are intrinsically the best-adapted to naturally survive drought, fire, and insects.

Derek Lee. January 14, 2017. Blog post: Proposed Forest Thinning Will Sabotage Natural Forest Climate Adaptation and Resistance to Drought, Fire, and Insect Outbreaks. http://dereklee.scienceblog.com/34/proposed-forest-thinning-will-sabotage-natural-forest-climate-adaptation-and-resistance-to-drought-fire-and-insect-outbreaks/

Another study shows that slower growing Ponderosa pine trees may be better adapted to survive drought. This might mean that logging prescriptions that favor removal of smaller trees might be making Ponderosa pine forests less resilient. University of Montana. June 18, 2019. Cell structure linked to longevity of slow-growing Ponderosa Pines. https://www.sciencedaily.com/releases/2019/06/190618174358.htm ("Slow-growing ponderosa pines may have a better chance of surviving longer than fast-growing ones, especially as climate change increases the frequency and intensity of drought, according to new research from the University of Montana. ... [A] key difference between fast and slow growers resides in a microscopic valve-like structure between the cells that transport water in the wood, called the pit membrane. The unique shape of this valve in slow-growing trees provides greater safety against drought, but it slows down water transport, limiting growth rate."). *citing* Beth Roskilly, Eric Keeling, Sharon Hood, Arnaud Giuggiola, Anna Sala. Conflicting functional effects of xylem pit structure relate to the growth-longevity trade-off in a conifer species. Proceedings of the National Academy of Sciences, 2019; 201900734 DOI: 10.1073/pnas.1900734116.

The bottom line is that nature does a good job of picking trees that are fit for survival in a stressful world. Foresters cannot predict which trees will survive drought and insects, so they will kill some trees that are relatively more fit and retain trees that are relatively less fit. This indicates that natural mortality will lead to greater forest resilience, while logging will lead to reduced forest resilience.

> **e360**: So by trying to fix the problem, we sometimes only make it worse.
> **Six**: As humans, we have this feeling that if something goes awry, we need to fix it, and that somehow we can. I don't think that we necessarily always know what needs to be done, or that when we do apply management that we are always actually doing the right

thing. Sometimes we just need to realize that nature can sort itself out perhaps better than we can.

…

[M]odels assume that the forest is genetically homogenous, that everything is the same. And they are not. I suspect that there is a lot more genetic variability out there that will allow for more adaptation and greater persistence than we currently anticipate.

e360: You are suggesting that evolution will kick in and help to a degree?
Six: If we let it. If we don't go out and replant with stock that may not be genetically correct, if we don't thin or cut down trees that may have been selected by beetles or drought to survive. We have to get smart about how we are treating our forest if we're going to help nature's process of adaptation to proceed.

Richard Shiffman interview with Diana Six. 04 JAN 2016: INTERVIEW- How Science Can Help to Halt The Western Bark Beetle Plague http://e360.yale.edu/content/feature.msp?id=2944

A press release from the University of Montana says:

A University of Montana researcher has discovered that mountain pine beetles may avoid certain trees within a population they normally would kill due to genetics in the trees.

UM Professor Diana Six made the discovery after studying mature whitebark and lodgepole trees that were the age and size that mountain pine beetle prefer, but had somehow escaped attack during the recent outbreak.

After DNA screening, survivor trees all contained a similar genetic makeup that was distinctly different from the general population that were mostly susceptible to the beetle.

"Our findings suggest that survivorship is genetically based and, thus, heritable," Six said, "which is what gives us hope."

...

"Our results suggest that surviving trees possess a wealth of information that can be used to inform our understanding of the genetic and phenotypic bases for resistance and to develop management approaches that support forest adaptation," Six said.

PUBLIC RELEASE: 16-AUG-2018. UM Researcher discovers genetic differences in trees untouched by mountain pine beetles. THE UNIVERSITY OF MONTANA https://www.eurekalert.org/pub_releases/2018-08/tuom-urd081618.php *citing* Six, Diana L.; Vergobbi, Clare; Cutter Mitchell. 2018. Are Survivors Different? Genetic-Based Selection of Trees by Mountain Pine Beetle During a Climate Change-Driven Outbreak in a High-Elevation Pine Forest. Frontiers in Plant Science 9(993). https://doi.org/10.3389/fpls.2018.00993; https://www.frontiersin.org/articles/10.3389/fpls.2018.00993/full. ("We found that surviving mature trees in a high elevation forest of whitebark and lodgepole pine were genetically distinct from “general population” trees that were assumed to represent the genetic structure of the population pre-outbreak and without selection by the beetle. In line with our hypothesis, a low percentage (<10%) of “survivor” genotypes were identified within the general population. ... We found surprisingly high levels of differentiation between survivor and general population trees in both species of pine. ... With climate change supporting the invasion of aggressive bark beetles into naïve forests, and predictions of more frequent and severe outbreaks, it is increasingly important to understand the capacity of trees to adapt and persist (Millar et al., 2007; Ramsfield et al., 2016). ... While the massive mortality of pines in western North America in recent years is cause for concern, we should also look at these hard-hit forests as opportunities to learn. In almost all cases, affected forests are not completely dead–they retain many living large diameter trees. If these trees are genetically different than those selected and killed by the beetles as our study suggests, these trees may aid in *in situ* adaptation and persistence. They may also be key to developing management and trajectories that allow for forest adaptation. For example, retaining surviving trees as a primary seed source, rather than removing them during salvage operations could support *in situ* adaptation. In contrast, the effects of natural selection in these stands could be instantly negated by clearcutting or replanting with general seed stock. Supporting forest adaptation is critical in this time of rapid change (Millar et al., 2007). Given the great expanses of forest that are being affected by climate change and the fact that most will need to adapt *in situ*, it is imperative we begin to move past structural approaches to consider the genetic capacity of forest trees to adapt. The high degree of standing genetic variation found in most forest trees indicates many will have considerable ability to adapt. We need to be cognizant of adaptation that is occurring so that our management approaches act to support rather than hinder natural selection for traits needed under future conditions.”)

George Wuerthner often reminds public land managers that

> … there is significant genetic variation in individual trees, and thinning the forest can reduce the genetic diversity of the remaining stand, in effect, reducing its "resilience" and the ability of the forest ecosystem to adapt to changing conditions.
> [Studies] show that ponderosa pine seedlings have tremendous variation in their adaptation to drought and mature trees ability to fend off bark beetles. Under natural conditions, the beetles and drought would [selectively] eliminate the trees without these adaptations. But the average forester with his or her paint gun marking trees has no idea of the genetic makeup of the trees they are logging. Yet I do not even hear any sense of caution from the collaborative about this matter. They are of the belief that logging creates resilience. In fact, it impoverishes the forest ecosystem.

Wuerthner, George. 3-28-2017 Email to Deschutes Collaborative via Vernita Ediger, *citing* Kolb, T.E., Grady, K.C., McEttrick, M.P., and A. Herrero 2017. Local-Scale Drought Adaptation of Ponderosa Pine Seedlings at Habitat Ecotones. For. Sci. 62(6), pp.641-651. http://dx.doi.org/10.5849/forsci.16-049 (“The large amount of phenotypic variation within populations suggests the potential for future evolution of stress tolerance…”) and Pinnell, Sean,

2016. MS Thesis: "Resin Duct Defenses In Ponderosa Pine During A Mountain Pine Beetle Outbreak: Genetic Effects, Mortality, And Relationships With Growth" (2016). Paper 10709. http://scholarworks.umt.edu/cgi/viewcontent.cgi?article=11753&context=etd. ("Analyses at both the phenotypic and genetic levels indicated that drought significantly predisposed some trees and families to mortality …").

Note also, Pinnell (2016) found that fast growing trees are not necessarily more fit to survive drought and insects. ("I found no evidence of a resin duct defense-growth tradeoff. … [F]aster growing families did not suffer lower mortality.") Foresters often identify stands for thinning based on their growth rate as measured by annual growth rings/inch, and they identify trees for retention based on observed vigor and form. This study indicates that these factors may not be associated with resistance to mortality. Again, foresters think they are improving forest resilience, but they may be removing trees that are more fit, and retaining trees that are less fit, leaving more ill-fitting genes in the stand to reproduce and leaving the stand less resilient over the long term.

> Generally speaking, outbreaks of beetles can facilitate the development of a forest that is structurally, genetically and compositionally more diverse (Axelson et al., 2009) and therefore perhaps less prone to subsequent beetle attack (Amman, 1977). Thus, despite causing mortality of many individual trees, outbreaks can also play a critical role in ecosystem processes (Berryman, 1982).

Black, S. H., D. Kulakowski, B.R. Noon, and D. DellaSala. 2010. Insects and Roadless Forests: A Scientific Review of Causes, Consequences and Management Alternatives. National Center for Conservation Science & Policy, Ashland OR. http://www.geosinstitute.org/images/stories/pdfs/Publications/RoadlessAreas/FireandBugReport.pdf.
http://www.xerces.org/wp-content/uploads/2010/03/insects-and-roadless-forests1.pdf

> Epidemics of forest insects and pathogens have always occurred, and the selective killing of susceptible trees tends to increase overall stand fitness (Haack and Byler 1993). Spruce budworm, for example, may help maintain ecosystem health by selectively killing weaker, genetically inferior trees and thus increasing resistance to future outbreaks (Alfaro et al. 1982).
>
> ...
>
> Mountain pine beetle epidemics are part of a natural boom-and-bust cycle (Amman 1977). Large populations of beetles selectively kill large numbers of the most susceptible trees. Killing these trees facilitates the development of a forest that is structurally, genetically, and compositionally more diverse and therefore less prone to beetle attack in the long run (Amman 1977).

Black, S.H. 2005. Logging to Control Insects: The Science and Myths Behind Managing Forest Insect "Pests." A Synthesis of Independently Reviewed Research. The Xerces Society for Invertebrate Conservation, Portland, OR. http://www.xerces.org/wp-content/uploads/2008/10/logging_to_control_insects1.pdf *citing* Amman, G.D. 1977. The role of the mountain pine beetle in lodge pole pine ecosystems: Impact of succession. In *The Role of Arthropods in Forest Ecosystems: Proceedings in the Life Sciences,* W.J. Mattson, ed. Pp. 3–18. New York: Springer–Verlag. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1110&context=barkbeetles

Ideas for restoring eastside forests from the spotted owl recovery plan.

Consider the recommendations for dry forest landscapes found in the final spotted owl recovery plan. Even though this forest is outside the range of the spotted owl, there are places on the eastside of the Cascades that do have owls and the recovery plan makes some nice recommendations for restoring ecological *process* (as opposed to specific habitat conditions just for the spotted owl). There are a number of species other than the spotted owl that prefer complex forests (e.g. goshawk, pileated woodpecker, marten, fisher, flammulated owl, three-toed woodpecker) so there is no reason that these recommendations should not be relevant here.

The final recovery plan recognizes the importance of "restoring sustainable ecological conditions" (p 22); "mature and old trees" (p 22); "old trees regardless of diameter" (p110); "maintain medium and large tree structure" (p 112); "smaller size classes of fire tolerant species provide the recruitment resource" (pp 23, 109); removing canopy fuels is "least important" (p 109); "focus on thinning stands created by past harvest" (p 23); "most forest landscapes, even in dry ponderosa pine environments, included some level of mixed and high severity wildfire under natural conditions" (p 104); "The key ingredients in all management to produce, conserve, or protect dry east-side old forest is the retention or generation of sufficient numbers of large and very large, old ponderosa pine, western larch, and (in some cases) Douglas-fir and the maintenance of both meso- and fine-scale patchiness among and within stands." (p 107); apply treatments unevenly within and among stands (p 110); "incorporate spatial heterogeneity of dry forest stand structure into restoration treatments" (p 112); outside of high quality owl habitat patches "maintain[] structural conditions supporting prey occurrence and abundance in current or potential NRF habitat, maintain[] structural conditions conducive to Northern Spotted Owl foraging, and allow[] for rapid development of replacement NRF habitat." (pp 112-113); "Spotted Owls and their prey may be negatively affected by some fuels treatment activities. If so, these negative effects should be weighed in any decision to apply treatments on a particular site. We note that canopy closure is a key issue, and suggest that treatments affecting this be limited" (p 113) "lack of follow-up [fuel] treatments would likely increase fire risks quite dramatically" (p 113). In the recommendations above, references to spotted owl NRF, could just as well apply to goshawk NRF, pileated woodpecker habitat, Pine Marten habitat, etc. See USFWS. 2008 Final Recovery Plan for the

Northern Spotted Owl.
http://www.fws.gov/pacific/ecoservices/endangered/recovery/NSORecoveryplanning.htm.

FWS response to comments on the draft recovery plan says, "From a recovery planning perspective, the treatment prescriptions should be designed to reduce fire risk, not to provide commercial products. … We agree that decadence of stands is an important aspect of spotted owl habitat, and that spotted owl habitat is benefited by managing toward decadence. We believe the plan does encourage the development and inclusion of decadence … "
http://www.fws.gov/pacific/ecoservices/endangered/recovery/pdf/NSO_RPApp_F_Response_to_Comments_5_7_08.pdf.

Don't Be Anthropocentric About Forest Health

Some species, in fact many species, like dense thickets of vegetation and dead trees. Snowshoe hares like thickets and therefore so do Lynx. Flammulated owls like to roost in dense thickets and deer and elk use them to hide. Many species, including marten, ringtail and many varieties of woodpeckers and bats like an abundance of snags and down logs, so a forest that is "unhealthy" to a forester, might be just great for them. We should not impose our human vision of neatness and order on the sometimes chaotic and "messy" patterns of nature which work just fine for many species.

For instance, Cherry (1997) states:

> "The black-backed woodpecker appears to fill a niche that describes everything that foresters and fire fighters have attempted to eradicate. For about the last 50 years, disease and fire have been considered enemies of the 'healthy' forest and have been combated relatively successfully. We have recently (within the last 0 to 15 years) realized that disease and fire have their place on the landscape, but the landscape is badly out of balance with the fire suppression and insect and disease reduction activities (i.e. salvage logging) of the last 50 years. Therefore, the black-backed woodpecker is likely not to be abundant as it once was, and continued fire suppression and insect eradication is likely to cause further decline."

Cherry, M.B. 1997. The Black-Backed And Three-toed Woodpeckers: Life History, Habitat Use, And Monitoring Plan. Unpublished Report *on file with* U.S. Department Of Agriculture, Lewis And Clark National Forest, P.O. Box 869, Great Falls, Mt 59403. 19 pp.

Forest Health is a vague and unscientific term. Montana Public Radio reported on this in 2017:

> One of the lines Senator Daines often uses when talking about public lands management is, “a managed forest is a healthy forest.”
> "One of the problems is, 'healthy' doesn't have a scientific definition," Larson said, "so, when we come at it from a technical perspective, it can mean whatever we want it to mean. Some of the most intensively managed forests in the world are in Northern Europe, and they are in a biodiversity crisis, because they have mismanaged their dead wood. They never let their trees get old, they never let 'em die. They cut 'em down and take them to the mill, and there is a horrible deficit of dead wood in those forests. And as a consequence, they're compromised, they're not functioning, they're not providing the habitat for all the native biodiversity, the native wildlife species.

ERIC WHITNEY 2017. Forest Ecologist Comments On Senator Daines' Fire Call. Montana Public Radio. Sept 14, 2017. http://mtpr.org/post/forest-ecologist-comments-senator-daines-fire-call

The agency should be more explicit in describing the ecological goals they are seeking and the trade-offs inherent in reaching those goals.

> … as ecologist Robert Lackey describes, there is no universal definition of ecosystem health, yet many environmental policy issues are based on the idea of restoring or improving the health of ecosystems. Lackey calls ecosystem health a “value-based ecological concept” based on subjective assumptions that “masquerade as science.” Ecosystems have no preferences; people do.

Regan, S. 2016. . ENVIRONMENTALISM WITHOUT ROMANCE - Science alone cannot resolve most environmental issues. PERC Report: Volume 35, No.1, Summer 2016 http://www.perc.org/articles/environmentalism-without-romance.

Oregon’s Federal Forest Working Group admits that “At present there is no good way to describe project outcomes in terms of improved forest health and resiliency.” Federal Forest Dashboard - Management and Restoration Indicators for Six National Forests in Eastern Oregon | A Project of the Federal Forest Working Group | January 31, 2017, version. http://orsolutions.org/wp-content/uploads/2011/08/Dashboard-1-31-17-version.pdf. Without measurable outcomes, management becomes overly discretionary and accountability becomes impossible. That is why the agencies have problems with public trust and social license.

> There is no scientific consensus on the definition of “sustainable forestry,” nor does any existing Massachusetts law or regulation define the term. There are no quantifiable standards for measuring what is “sustainable” and what is not, no process for monitoring forestry projects to assess the results of their operations, and no system for enforcing standards of “sustainability.”
>
> ...

... "[t]he definition of Sustainable Forestry Management, which can be found in 225 C.M.R.14.02, is based off the definition of Sustainable Forestry from the Dictionary of Forestry provided by the Society of American Foresters."71 However, the cited definition entirely lacks quantification or measurable standards.72 It also dates from 1998, before the looming threats to biodiversity from climate change were fully understood. This definition is a completely inadequate basis for making decisions on forest management that will have an impact on climate change, biological diversity, and other critical values that extend for centuries into the future.

> The proposed definition of "Sustainable Forestry Management" is similarly meaningless. See Proposed 225 C.M.R. 14.02. There are no quantifiable standards for measuring what is "sustainable" and what is not, no process for monitoring forestry projects to assess the results of their operations, and no system for enforcing standards of "sustainability." It is unclear how this standard could be enforced. Based on this definition, there is no indication of how one would review a logging plan, inspect the site of a proposed logging project, or assess the outcome of a logging job and determine whether it meets the definition of "Sustainable Forestry Management."

> *fn/71* Proposed Guideline on Eligible Biomass Fuel for Renewable Generation Units, at 1.

> *fn/72* See Sustainable Forest Management, THE DICTIONARY OF FORESTRY (John A. Helms ed., 1998) ("Sustainable forest management (sustainable forestry) (SFM)—this evolving concept has several definition . . . [listing menu of abstract concepts].").

Conservation Law Foundation et al 2019. Joint Environmental Comments, Proposed Changes to Massachusetts' Revised Renewable Fuel Standards, 225 C.M.R. 14.00.

Do not abuse the concepts of disturbance ecology.

We agree that ecosystems are driven and renewed by disturbance, while we also must be mindful of the often long intervals between disturbance events. "Disturbance ecology" must not become a drum beat for abandoning "static management" to allow more logging. *Just as fine classical music is built upon the careful blending of notes and the carefully chosen intervals of silence between the notes, fine forests and aquatic ecosystems develop from both disturbances and the often long intervals of growth and recovery between disturbances*. The chronic effects of industrial logging do not respect the natural rhythm of disturbance and quiet.

Tom Spies emphasizes the lack of disturbance is just as important as the disturbance in making old-growth forests.

> Central to all of these [old-growth] perspectives are the changes in forest ecosystems and communities during long periods of time that are free from large, high severity disturbance. The central scientific question is what happens to a forest when it develops

(including growth and death) over a long time without complete destruction by disturbances such as fire, logging or wind?
http://www.fsl.orst.edu/Oldgrowthworkshop/statements/Spies.pdf.

Manage within the historic range of variability with restoration efforts that increase under-represented elements and reduce over-represented elements.

The agency seems to be very focused on restoring the historic range of variability with respect to tree density, while giving much less attention to other ecological conditions that are outside of the HRV. We need to increase the pace and scale of restoration of under-represented ecological features such as road density, roadless areas, disturbance regimes, undisturbed soil, non-bovine herbivory, absence of weeds, recruitment of large trees to large snags, and functional floodplains. We urge the FS to move more aggressively to reduce road density, grow roadless areas, and restore fire and floodplains.

- Existing intact habitats should be protected, while restoration focuses on areas that have been degraded by past management. The agency should defer logging in the stands older than 80 years, because these areas are relatively more intact, and because older stands do not respond as well to thinning, making the younger stands with greater expectations of thinning response a much higher priority,
- Roads are an "alien" structure in our watersheds and though they are a necessary evil, management efforts must reduce the over-built road system to the bare minimum. Riparian roads that separate streams from their flood plains and or separate them from sources of large woody debris should be the very high priority for removal. Mid-slope roads that cross streams and steep slopes are also a high priority because they are likely to disrupt the natural movement of sediment and large woody debris and deprive streams of this vital material.
- Most mature and old-growth forest habitat historically occurred in large habitat patches which are currently greatly under-represented relative to the historical condition, so existing unroaded areas should be protected, while road closures are designed and prioritized to recreate more of the large intact habitat blocks.
- Dense young stands with little structural retention (e.g. stands resulting form past clearcutting and densely replanted) are vastly over-represented relative to the historical condition. Management should focus on thinning stands that are accessible from existing roads. Thinning should always use variable retention techniques that create a variety of microhabitats and habitat gradients within and between stands. Unthinned "skips" provide important refugia and centers for dispersal for post-thinning recovery. Heavily thinned "gaps" provide important landscape scale diversity. Skips should generally be much larger than the gaps.
- Stands that were artificially planted following logging often have one or a few species (such as Douglas fir) that are over-represented. Restoration thinning will require that tree species other than Douglas fir be retained as much as possible, especially large specimens. Certain trees such as Pacific yew, western redcedar, (and Sitka spruce in some areas) are under-represented and need to be planted or otherwise encouraged. Tall shrubs

and other understory plants are underrepresented in dense plantations and will be helped by appropriate variable density thinning.

- Snags and dead wood habitat are critical components of healthy forests and provide not only essential habitat for a wide range of fish & wildlife, but they also provide essential functions related to soil stability and soil formation, nutrient cycling, and hydrology that are intimately tied to the very productivity of the forest. Dead wood is also far under-represented relative to the historical condition, so all future activities must manage for, not against, "decadence." This can include leaving existing snags and down wood, selectively killing some live trees, and retaining some extra live trees on site for future recruitment of dead wood.
- Healthy streams are also under-represented. Restoring connectivity and functionality to the stream network will include: restoring instream flows; removing road culverts and other non-native structures that block passage of aquatic organisms as well as blocking delivery of beneficial sediment and large wood structure to streams; restoring stream-side vegetation structure; and restoring natural processes such as floods and structure-rich landslides.

Most eastside forests can be restored by focusing thinning efforts on dense young forests, not mature & old-growth forests.

Forest insects and diseases enhance biodiversity and help regulate a healthy forest.

The agencies need to stop thinking about forests as an agricultural crop and start thinking about forests as complex, self-organizing systems. When forests become dense, natural mortality processes, like insects, disease, and fire, are not a problem, rather they are part of the solution. Natural mortality increases the diversity and complexity of the forest. Mortality creates opportunities for new organisms, thus enhancing biodiversity. Jonathan Romeo 2016. Beetle-kill zones surprisingly rich in biodiversity. Durango Herald. March 2, 2016. http://www.durangoherald.com/article/20160302/NEWS06/160309880/0/SEARCH/Beetle-kill-zones-surprisingly-rich-in-biodiversity (Forests "scarred by the spruce beetle outbreak, can elicit strong emotions in the nature lover. Several logging sales may be on the way, but new research suggests ravaged trees can create an ecologically vital habitat worth saving. … The Forest Service has long maintained such timber sales benefit the health of the ecosystem as it transitions from an old-growth to new-growth forest, but research from the University of Montana, as well as several conservation groups, challenges that idea. … After the beetle moves on, woodpeckers feed on the larvae left behind, which creates nest cavities in dead trees for other species – such as bluebirds, chickadees and even squirrels – who are unable to make the safe havens themselves. Then come the wildflowers, which thrive on the exposed understory of the forest, typically covered in shade. Flies and other insects arrive to feed on the flowers, and in turn bring birds, bats and other small mammals, which attract larger predators. "What you end up with is a very rich and biodiverse ecosystem," Hanson said. Clark University associate professor Dominik Kulakowski agreed. He said the result, a "snag forest," is a favorable habitat for many invertebrates and vertebrates because of the creation of canopy gaps and enhanced growth of understory plants. "Outbreaks create snags that may be used by various birds and mammals, including woodpeckers, owls, hawks, wrens, warblers, bats, squirrels, American marten and lynx," Kulakowski said." By removing the trees, you remove this process, both Hanson and Kulakowski said.)

> **Failure to embrace natural disturbance as part of the solution rather than part of the problem.** Throughout the CFCP, wildfire, insect mortality, and drought mortality are all described as undesirable carbon losses to be mitigated through preemptive thinning when it is generally understood that California forests are in need of more fire not less (Stephens et al., 2007; Marlon et al., 2012; Baker, 2015) and that insect mortality, and drought mortality function primarily to thin forests (Harvey et al., 2013; Meigs et al., 2016), much like that proposed through selective harvest.

Campbell, J.L. 2017, Comments on the Jan 2017 draft California Forest Carbon Plan. http://www.fire.ca.gov/fcat/downloads/FCAT_PublicComment/Campbell_CFCP_Review_Final-2nd.pdf.

> The scourge of forests, the [beetle], is usually described with words like "destructive" and "pest." A recent study based on data collected by citizen scientists suggests that one more adjective might apply, at least from a bird's perspective: "delicious."

USDA Forest Service - Northern Research Station (2013, August 8). Increase in woodpecker populations linked to feasting on emerald ash borer. ScienceDaily. Retrieved August 12, 2013, from http://www.sciencedaily.com/releases/2013/08/130808124229.htm

Several recent studies suggest that beetles may in fact help forests adapt to changing climate conditions.

- Peter T. Soul, Paul A. Knapp & Justin T. Maxwell (2013) "Mountain Pine Beetle Selectivity in Old-Growth Ponderosa Pine Forests, Montana, USA" Ecology and Evolution Volume 3 Issue 5 pp.1141-1148. https://libres.uncg.edu/ir/asu/f/Soule_Peter_2013_Mountain%20Pine%20Beetle_orig.pdf;
- Millar, C.I. et al. 2007. Response of high-elevation limber pine (Pinus flexilis) to multiyear droughts and 20th-century warming, Sierra Nevada, California, USA. Canadian Journal of Forest Research 37: 2508-2520. https://www.fs.fed.us/psw/publications/millar/psw_2007_millar031.pdf;
- Millar, C.I. et al. 2012. Forest mortality in high-elevation whitebark pine (Pinus albicaulis) forests of eastern California, USA; influence of environmental context, bark beetles, climatic water deficit, and warming. Canadian Journal of Forest Research 41: 749-765. https://www.fs.fed.us/psw/publications/millar/psw_2012_millar001.pdf;

The NEPA document needs to consider the beneficial effects of insects and disease, for example: the value of mistletoe brooms as wildlife structures; the value of root rot in creating pockets of down woody debris, enhancing biodiversity, and creating gaps with complex canopy architecture; the value of bark beetles as food sources for diverse wildlife and as vectors of sapwood decay fungi rendering the tree more suitable for wildlife habitation.

> Rather than pests, both the bark beetle and wood-boring beetle species at issue are native species that fill essential roles in native forests. They evolved in these forests over many millennia; in many ways, they're a cornerstone of the biodiversity in forest ecosystems in California and the western U.S.
>
> Periods of drought are natural in the western U.S., and most dead trees result from occasional pulses of drought and fire. These native beetle species require recently dead trees to survive, since their larvae depend upon the unique microhabitat and food conditions found under the bark of recent snags. Woodpeckers depend upon these beetle larvae for their food, and the woodpeckers need snags, which are softer than live trees, so they can excavate nest cavities to raise their chicks.
>
> Every year these native woodpecker species, like the black-backed woodpecker, hairy woodpecker, and white-headed woodpecker, create a new nest cavity, allowing the previous cavities to be used by dozens of species that also require nest cavities but cannot create their own, such as bluebirds, nuthatches, wrens, and even small mammals like flying squirrels and pine martens. Raptors such as the northern goshawk and Cooper's hawk depend upon such birds for their food.
>
> Where pockets of dead trees occur, increased sunlight spurs the growth of native shrubs, which produce flowers and edible berries. These shrubs require high levels of sunlight, and cannot survive under the shade of a dense forest canopy. The flowers attract native flying insects -- bees, wasps, butterflies and moths -- which in turn provide food for flycatching birds and bats. The berries on these shrubs are essential food bears need to eat to fatten up before the long, cold winter, and the leaves on the shrubs provide forage for mule deer. The shrubs also create important nesting habitat for many shrub-nesting birds, many of which have become rare or are declining due to lack of habitat currently. Small mammals create dens in the shrubs and downed logs, providing a core food source for owls.
>
> The entire ecosystem and many of its inhabitants depend upon these native beetle species and an abundance of snags. No snags, no beetles. No beetles, no woodpeckers. No woodpeckers, no bluebirds, nuthatches, or other secondary cavity-nesters. No woodpeckers, bluebirds, etc., no hawks. Without an ample supply of snags, and healthy beetle populations, bears and deer also suffer.

> The fact is, an ecologically healthy forest has a lot of dead trees. Current science indicates that we have a deficit, not an overabundance, of dead trees in forests of California, relative to the needs of the dozens of cavity-nesting wildlife species that depend upon these snags for both food and homes.
> …
> Studies show that cavity-nesting wildlife species generally need at least four to eight snags per acre to have sufficient food and nest-cavity abundance. The rarest and most imperiled cavity-nesting species often require much higher levels.
>
> For example, the California spotted owl depends on dense, old forests with 8 to 12 snags per acre for nesting and roosting habitat, and generally even higher levels for foraging habitat, because snags and downed logs (after the snags fall to the ground) create excellent habitat for the owl's small mammal prey species. The rare black-backed woodpecker depends upon areas with at least several dozen snags per acre in order to have enough food to survive, since the birds feed on the larvae from native beetles found almost exclusively under the bark of dead trees.
>
> So, when you see a forested slope with some pockets of dead trees, don't lament it; rather, celebrate the sight as a positive sign for wildlife populations and the ecological resilience of the forest.

Chad Hanson 2015. COMMENTARY - In Defense of The Bark Beetle. October 14, 2015
http://www.kcet.org/news/redefine/rewild/commentary/in-defense-of-the-bark-beetle.html

Unplanned disturbance often enhances forest diversity. Eugene BLM’s Middle McKenzie Landscape Design says “Many times, small natural disturbances are biologically desirable since they increase the variability of the forest. When natural disturbances are small, the planned schedule of activities should not be altered.”
http://www.blm.gov/or/districts/eugene/plans/files/MMLD.pdf

> The massive insect epidemics that have plagued Pacific Northwest forests in recent years are mostly a reflection of poor forest health conditions, overcrowding, overuse of chemicals, fire suppression and introduction of monocultures or non-native species, a new report concludes.
>
> Beyond that, these insect attacks are actually nature's mechanism to help restore forest health on a long-term basis and in many cases should be allowed to run their course, according to Oregon State University scientists in a new study published this week in the journal Conservation Biology In Practice.
>
> Native insects work to thin trees, control crowding, reduce stress and lessen competition for water and nutrients, the researchers found. Some levels of insect herbivory, or plant-

eating, may even be good for trees and forests, and in the long run produce as much or more tree growth.

"There is now evidence that in many cases forests are more healthy after an insect outbreak," said Tim Schowalter, an OSU professor of entomology. "The traditional view still is that forest insects are destructive, but we need a revolution in this way of thinking. The fact is we will never resolve our problems with catastrophic fires or insect epidemics until we restore forest health, and in this battle insects may well be our ally, not our enemy."

Historically, Schowalter said, destructive forest insects such as the mountain pine beetle or tussock moth were native to Pacific Northwest forests and served an essential role in keeping them healthy. When trees became too crowded the insects would eliminate weaker trees and reduce competition. But since the beetles' reproductive pheromones only carried effectively about 15-20 feet, naturally open stands of mature pines were protected against widespread outbreaks.

In these same forests today, fire suppression has allowed shade-tolerant, fire-intolerant species to crowd the understory, create an entire forest stressed for water and nutrients, and beetles can skip from one weak tree to another across entire stands. But the solution in cases such as this, Schowalter said, is to address the fundamental issue of overcrowding through forest thinning, controlled fire and insect attack, allowing the pine beetles to actually help in the long-term process of restoring forest health.

It now appears that insects, which are the most abundant and diverse animals on Earth, are anything but destructive pests. Rather, they are major architects of the plant world in both structure and function, and in natural balance help to maintain healthy and productive forest ecosystems.

According to the new report, insects can influence their environment in five key ways:

- Insects aid decomposition, stimulate the breakdown of organic materials, enhance soil fertility and plant growth, burrow in soils and increase its porosity and water-holding capacity.
- Insects are herbivores that eat plants, influencing where they can grow. Sometimes they kill trees and other plants to reduce competition, and many times feed on trees without killing them in ways that actually improve the health and long-term growth of trees and forests.
- Insects are a key food source for vertebrates and other animals, and play a major role in the food chain.
- Insect are dispersal agents to carry seeds, fungal spores, and even other invertebrates from one place to another.
- Insects are pollinators, and in this role also help control the movement of plant species.

Through this multiplicity of roles, forest insects can help to control plant succession, dictate which plants will be allowed to grow or thrive in particular areas, and generally invigorate plant communities, the report said. Studies suggest herbivory levels as high as 40-50 percent make little or no difference to plant growth and survival, and this type of moderate herbivory clearly should not be "fought" with costly controls. Wood production in western U.S. pine forests reached or exceeded pre-attack levels 10-15 years following mountain pine beetle outbreaks, research has shown, and the more an individual Douglas-fir tree is defoliated by the tussock moth, the more it compensates afterwards with increased growth, given sufficient resources. The herbivory may alleviate drought stress by reducing a tree's demand for water, and also encourage more competitive interactions between plant species that ultimately work to the benefit of the tree.

Insects may be so important to soil fertility that they may be a better barometer of forest ecosystem health than the larger trees or animals which live there, researchers say. In natural forest communities there are more than 200 species of arthropods and more than 200,000 individuals in a square meter of soil, and the numbers of these arthropods can tell more than chemical tests about soil concerns such as compaction and nutrient cycling. A study by another OSU researcher showed residual impacts on soil invertebrate populations from a site that had been clearcut and slash burned 40 years earlier.

In their natural role, insects are usually helpful to the forest and rarely cause large epidemics.

"When you have a highly destructive insect epidemic, what that really should be telling us is not that we have an insect problem, but that we have a forest health problem," Schowalter said. "It's monocultures and fire suppression that cause insects to become nuisances. The pests that plague us are all too often of our own making."

As these systems become more fully understood, Schowalter said, it should be possible to work with insects, rather than against them, to produce new solutions to maximize the yield of forest commodities while achieving conservation goals and healthier ecosystems.

"It's really simple on one level," Schowalter said. "We have to pay more than lip service to the balance of nature."

Oregon State University. "View Of Forest Insects Changing From Pests To Partners." ScienceDaily, 31 October 2001.
http://www.sciencedaily.com/releases/2001/10/011030230203.htm.

See also:

- Insect Ecology - An Ecosystem Approach Edited by Timothy D. Schowalter Academic Press. 2000. and Schowalter, TD and J. Withgott. 2001.
- Rethinking insects: What would an ecosystem approach look like? Conservation Biology In Practice 2(4): 11-16.

- Waldbruaer, Gilbert. 2003. What Good are Bugs? Insects in the Web of Life. Harvard University Press. Cambridge, MA. 316 pp.
- Maddie Oatman 2015. Bark Beetles Are Decimating Our Forests. That Might Actually Be a Good Thing. They gobble up trees and send politicians into a frenzy. But do the bugs know more about climate change than we do? Mother Jones, May/June 2015 http://m.motherjones.com/environment/2015/03/bark-pine-beetles-climate-change-diana-six

Thinning can make insect problems worse.

Thinning activities attracting beetles to the area through the release of terpenes from fresh wood chips, slash, or wounded green trees. If insect attack is a concern, the agency must consider and disclose the factors that tend to attract insects and determine whether thinning will make things better or worse.

Results of the fire surrogates study "indicate that the probability of mortality of large-diameter ponderosa pine from bark beetles and wood borers was directly related to surface fire severity and bole charring, which in turn depended on fire intensity, which was greater in units where thinning increased large woody fuels." Andrew Youngblood, James B. Grace, And James D. Mciver. 2009. Delayed conifer mortality after fuel reduction treatments: interactive effects of fuel, fire intensity, and bark beetles. Ecological Applications, 19(2), 2009, pp. 321–337 http://www.esajournals.org/doi/pdf/10.1890/07-1751.1.

A recent study showed that thinning can increase mortality from bark beetles and increase fuel loading and crown fire behavior.

> We simulated management scenarios with and without thinning over 60 years, coupled with a mountain pine beetle outbreak (at 30 years) to examine how thinning might affect bark beetle impacts, potential fire behavior, and their interactions on a 16 000-ha landscape in northeastern Oregon. We employed the Forest Vegetation Simulator, along with submodels including the Parallel Processing Extension, Fire and Fuels Extension, and Westwide Pine Beetle Model. We also compared responses to treatment scenarios of two bark beetle-caused tree mortality susceptibility rating systems. … **[C]ontrary to expectations, the Westwide Pine Beetle Model predicted higher beetle outbreak-caused mortality in thinned versus unthinned scenarios. Likewise, susceptibility ratings were also higher for thinned stands.** Thinning treatments favored retention of early seral species such as ponderosa pine, leading to increases in proportion and average diameter of host trees. **Increased surface fuel loadings and incidence of potential crown fire behavior were predicted postoutbreak**; …

Ager, A.A.; McMahan, A.; Hayes, J.L.; Smith, E.L. 2007. Modeling the effects of thinning on bark beetle impacts and wildfire potential in the Blue Mountains of eastern Oregon. Landscape and Urban Planning. 80: 301–311.

"Good" fire is possible and may be preferable to the ground disturbance of logging.

Recent studies show that the area affected by fire may be increasing but fire severity is not increasing. Low and moderate fire severity still dominate and those fires are essentially thinning from below but without building roads or removing ecologically valuable biomass.

Many NEPA analyses present the effects of wildfire under the no action as negative, and the effects of wildfire under the action alternatives as beneficial. However, the 2017 Fuels Report for the East Hills Project on this Fremont-Winema NF admits that wildfires are expected to have beneficial effects even under the no action alternative - “Overall expected value of fire effects is moderately beneficial. This assumes that fires burn throughout the range of conditions – actual current practice is to suppress fires that are most likely to be beneficial.” https://www.fs.usda.gov/nfs/11558/www/nepa/101283_FSPLT3_4264365.pdf. Based on this information, the correct way to describe the effects of the action and no action alternatives with respect to how they interact with wildfire is varying degrees of beneficial impacts. This also indicates a need to modify fire suppression practices and work *with* fire when weather conditions are favorable.

> Most contemporary fires in mixed conifer forests of western North America are mixed-severity fires. In the Pacific Northwest, mixed-severity fires include unburned and low severity areas that account for 50%–60% of total burn area, and only 13% of total burn area experiences high severity (90% tree mortality; Halofsky et al., 2011; Law & Waring, 2015).

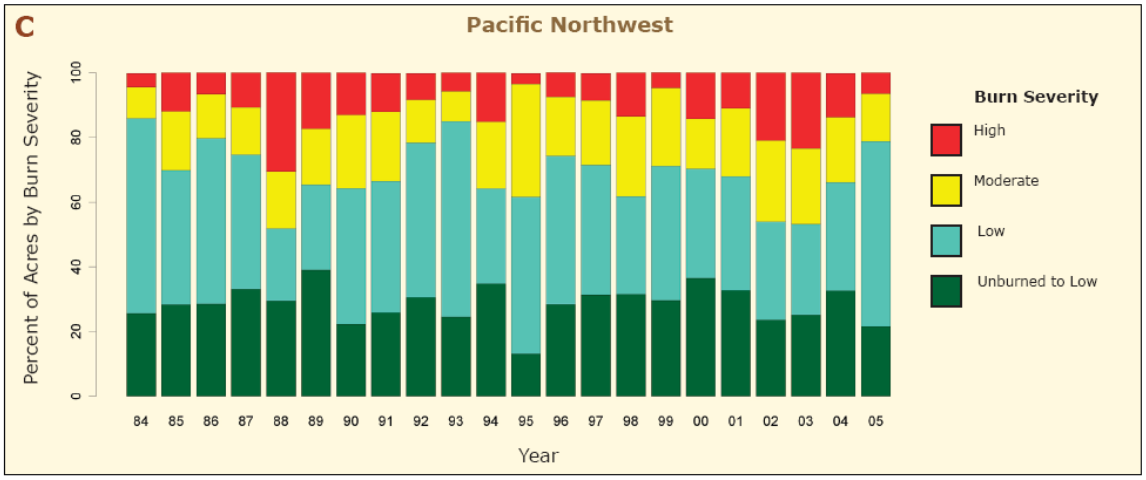
Polly C. Buotte, Samuel Levis, Beverly E. Law, Tara W. Hudiburg, David E. Rupp, Jeffery J. Kent. Near-future forest vulnerability to drought and fire varies across the western United States. Global Change Biology, 2018; DOI: 10.1111/gcb.14490. https://onlinelibrary.wiley.com/doi/pdf/10.1111/gcb.14490

An analysis of trends in burn severity in the Northwest over the last 20 years found that “there is a [small but statistically] significant increase in average fire size between 1984-1999 and 2000-2005 [yet] there is still no trend toward higher burn severity… MTBS data does not support the assumption that wildfires are burning more severely in recent years.” The majority of fire effects remain low severity and the proportion of high severity fire is not showing an increasing trend, therefore one could conclude that the increased incidence of fire on the landscape is just a re-establishment of a natural process. Natural fire is not a problem, but a solution to decades of fire suppression.

> The majority of area burned falls within the unburned to low severity range, with relatively low annual variation in these severity classes. The high and moderate severity classes show higher relative variation between years, suggesting that these classes may be most influenced by variation in climate, weather, and seasonal fuel conditions. …
> **Percentage of Area by Burn Severity–PNW & PSW**

• 28 percent—unburned to low severity
• 36 percent—low severity
• 21 percent—moderate severity
• 15 percent—high severity

…



…

The Unburned-to-Low and Low severity classes are also interesting because their proportions are relatively stable from year to year. The Unburned-to-Low class averages approximately 28 percent of the burned area with only ±6 percent variation from year-to-year (one exception in 1995) for the entire data record. This compares with the high severity class, which averages 15 percent of the area with ±11 percent variation. Also, in 82 percent of the years the combination of the Unburned-to-Low and Low severity classes was 60 percent of the burned area. The lower end of the burn severity spectrum appears to be fairly consistent across the data record and regularly comprises a majority of the burned area.

Schwind, B. (compiler). 2008. MTBS: Monitoring Trends in Burn Severity: Report on the PNW & PSW Fires — 1984 to 2005.
https://web.archive.org/web/20130214220819/http://www.mtbs.gov/reports/MTBS_pnw-psw_final.pdf

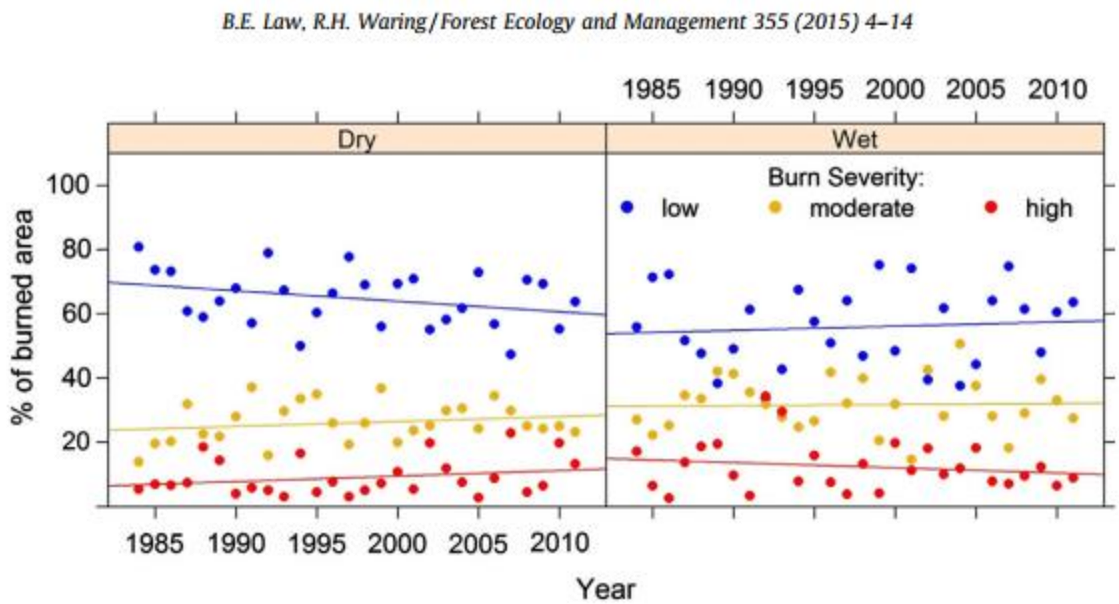
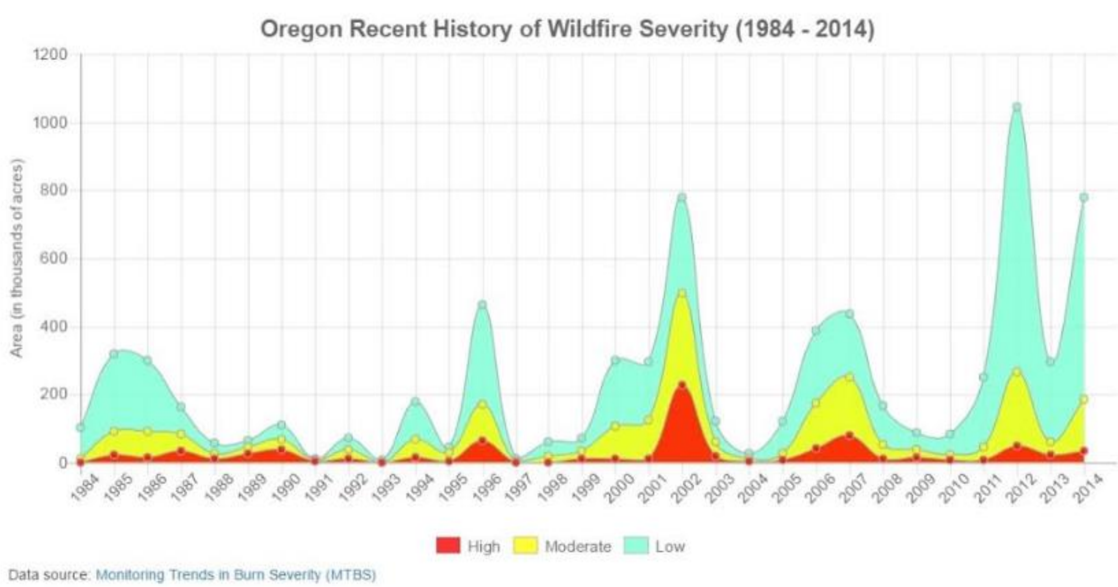


Fig. 2. The percentage of total area burnt within each burn severity class from 1984 to 2011 for dry (left panel, less than 600 mm year1) and wet (right panel) ecoregions in the Pacific Northwest. High severity fire accounted for an average of 9–12% of the total burn area and did not change significantly over time. Estimates are from the Monitoring Trends in Burn Severity database Eidenshink et al., 2007).

A recent review of wildfire activity nationwide shows that only 11% of fires burn uncharacteristically. Vaillant & Reinhardt 2017. An Evaluation of the Forest Service Hazardous Fuels Treatment Program—Are We Treating Enough to Promote Resiliency or Reduce Hazard? Journal of Forestry. 115(4):300 –308. July 2017.
https://doi.org/10.5849/jof.16-067.
https://www.fs.fed.us/pnw/pubs/journals/pnw_2017_vaillant001.pdf



Law, B.E., Waring, R.H. 2015. Review and synthesis - Carbon implications of current and future effects of drought, fire and management on Pacific Northwest forests. Forest Ecology and

Management 355 (2015) 4–14. http://terraweb.forestry.oregonstate.edu/pubs/law.fmec.2015.pdf
This study reported no significant trend in area burned, number of fires, or fire severity for the state of Oregon. Law, B. 2016. Forest C presentation to the Oregon Global Warming Commission, Forest Subcommittee. Oct. 6, 2016.
http://www.keeporegoncool.org/sites/default/files/meeting-supporting-files/BevLawSlides%20Forest%20C100616.ppt

Ray Davis et al (2015) -

> "… examined the MTBS data for any obvious temporal trends in wildfire severity, but did not detect a strong signal (Figure D-6). Over the course of 25 years, there appears to be a slight increase in the percentage of area burned by low and moderate severity wildfire, and a slight decrease in the percent of area burned in high severity wildfire, although these trends are not statistically significant.
>
> …
>
> While several studies have indicated that high severity fires are increasing across the western United States (Westerling et al. 2006, Dillon et al. 2011a, Miller et al. 2012), no such trends were apparent in the observed record within the range of the northern spotted owl (Figure D-6). The observed trends in increasing fire severity in various studies appear to be scale-dependent in that these trends were typically for the western United States as a whole. Much of the observed change is either occurring in other areas besides that are encompassed by the range of the northern spotted owl or becomes apparent only when analyzing a larger area that provides a much larger sample size."

Ray Davis et al 2015. RMP Revisions for Western Oregon BLM DEIS. Appendix D – Modeling Wildfires and Fire Severity.
http://www.blm.gov/or/plans/rmpswesternoregon/files/draft/RMP_EIS_Volume3_appd.pdf.

Meddens et al (2018) found that unburned area proportion exhibited no trend over three decades–

> One important and understudied aspect of fire regimes is the unburned area within fire perimeters; these areas can function as fire refugia across the landscape during and after wildfire by providing habitat and seed sources. With increasing fire activity, there is speculation that fire intensity and combustion completeness are also increasing, which we hypothesized would yield smaller unburned proportions and changes in fire refugia patterns. We sought to determine (1) whether the unburned proportion of wildfires decreased across the northwestern United States from 1984 to 2014 and (2) whether patterns of unburned patches were significantly different across ecoregions, land cover type, and land ownership. We utilized a Landsat-derived geospatial database of unburned islands within 2298 fires across the inland northwestern USA (including eastern Washington, eastern Oregon, and Idaho) from 1984 to 2014. We evaluated patterns of the total unburned proportion and spatial patterns of unburned patches of the fires across different ecoregions, land cover types, and land ownership. We found that unburned area

proportion exhibited no change over the three decades, suggesting that recent trends in area burned and overall severity have not affected fire refugia, important to post-fire ecosystem recovery ...

...

As the study period includes several regional large fire years and some record individual large fires, these results make clear that while fires may be increasing in size, fires are burning with enough heterogeneity on the landscape to maintain relatively consistent patterns of unburned patches. This is critical for several reasons, as changes in proportion, patch size, or patch density can have significant ecological effects (Fig. 6). Changes in either proportions or patterns of unburned patches could have considerable impacts to species that are sensitive to minimum habitat patch size requirements or distance between patches of fragmented habitat.

Meddens, A. J. H., C. A. Kolden, J. A. Lutz, J. T. Abatzoglou, and A. T. Hudak. 2018. Spatiotemporal patternsof unburned areas withinfire perimeters in the northwestern United States from 1984 to 2014. Ecosphere 9(2):e02029.10.1002/ecs2.2029. https://esajournals.onlinelibrary.wiley.com/doi/epdf/10.1002/ecs2.2029

See also, Alisa Keyser and Anthony Westerling, 2017. Climate drives inter-annual variability in probability of high severity fire occurrence in the western United States, Environmental Research Letters. Accepted Manuscript online 4 April 2017 https://doi.org/10.1088/1748-9326/aa6b10. ("We tested trends for WUS [western United States], each state, and each month. We found no significant trend in WUS high severity fire occurrence over 1984-2014, except for Colorado (table S1). While some studies have shown increasing fire season length, we saw no significant increase in high severity fire occurrence by month, May through October (figure S1). We found no correlation between fraction of high severity fire and total fire size, meaning increasing large fires does not necessarily increase fractional high severity fire area.")

We evaluated the effects of reintroduced frequent wildfire in unlogged, fire-excluded, ponderosa pine forest in the Bob Marshall Wilderness, Montana, USA. Initial reintroduction of fire in 2003 reduced tree density and consumed surface fuels, but also stimulated establishment of a dense cohort of lodgepole pine, maintaining a trajectory toward an alternative state. Resumption of a frequent fire regime by a second fire in 2011 restored a low-density forest dominated by large-diameter ponderosa pine by eliminating many regenerating lodgepole pines and by continuing to remove surface fuels and small-diameter lodgepole pine and Douglas-fir that established during the fire suppression era. Our data demonstrate that some unlogged, fire-excluded, ponderosa pine forests possess latent resilience to reintroduced fire. A passive model of simply allowing lightning-ignited fires to burn appears to be a viable approach to restoration of such forests.

Andrew J. Larson, R. Travis Belote, C. Alina Cansler, Sean A. Parks, and Matthew S. Dietz 2013. Latent resilience in ponderosa pine forest: effects of resumed frequent fire. Ecological

Applications, 23(6), 2013, pp. 1243–1249. http://www.cfc.umt.edu/forestecology/files/Larson_Belote_Cansler_Parks_Dietz_EcoApps_2013.pdf

Similarly, a study of fire trends in the Northern Rockies found that stand replacing fire increased only 5% (from 22% to 27%) over a 25 year period (during a warming climate trend). Thus wildfire remains a strong force for landscape diversity and heterogeneity. Brian J. Harvey , Daniel C. Donato, Monica G. Turner 2016. Drivers and trends in landscape patterns of stand-replacing fire in forests of the US Northern Rocky Mountains (1984–2010). Landscape Ecology. pp 1-17. http://link.springer.com/article/10.1007/s10980-016-0408-4

An analysis of the 2002 Eyerly fire revealed that "Fire of moderate severity killed 72% of all the trees; however, 91% of the killed trees were <20cm in DBH, a category which only accounted for 22% of prefire bole wood production (Fig. 2). Fire of moderate severity killed only 34% of trees >20 cm DBH,…" http://terraweb.forestry.oregonstate.edu/pubs2/GCB_1368.PDF.

"Previous large fires successfully aided suppression efforts by providing safe anchor points for fireline construction ⋯" from a description of the GW fire on the Deschutes NF. http://web.archive.org/web/20090116001742/http://www.fs.fed.us/fire/fireuse/success/R6/pnw-fuel-treatment-effectiveness-assessment-2007.pdf.

The agency is not permitted to saddle the no action alternative with a worst case scenario in terms of future fire. The NEPA document describes the no-action alternative in terms of its inherent high risk of intense future fire, but the NEPA document lacks any recognition: (a) that the probability of high severity fire is far less than certain, (b) if a high severity fire does occur during hot-dry-windy conditions, the environmental effects will be similar whether the area is treated or not, and (c) that during favorable conditions of weather and fuel moisture a low-severity or mixed-severity fire could occur in the project area and such as fire would likely accomplish much of what this project is attempting to accomplish without all the adverse consequences from ground disturbance. This shows a strong bias against the no-action alternative.

Fire in fact has beneficial impacts. For instance:

- Fire creates snags and down wood which are essential ecological features,
- Fire makes available light, moisture, nutrients, and growing space for diverse organisms;
- Fire makes nutrients available and cycles nutrients;
- Growth of cutthroat trout was positively correlated with wildfire severity in the Oregon Coast Range. Heck & Gresswell. 2006. CFER News.
- A study of the historic fire pattern in the Boundary Water Canoe Area showed that only large fires at the scale of the historic disturbance regime would truly restore the landscape vegetation pattern. Small fuel reduction treatments (both mechanical or prescribed fire)

> would probably not restore the historic landscape pattern, and might in fact continue the habitat fragmentation effect caused by recent management. Baker, William. 1994. Restoration of Landscape Structure Altered by Fire Suppression. Conservation Biology. vol 8, no. 3, Sept. 1994. Baker concluded that mechanical pre-treatment may not be required to restore fire adapted ecosystems. The NEPA analysis for this project should recognize the adverse impacts of mechanical fuel reduction on soil, water, weeds, wildlife, scenery, and must recognize that mechanical fuel reduction may not only not aid landscape restoration objectives but might actually conflict with them. Baker seems to say that the only legitimate value of small scale fuel treatments is to protect very specific resources such as homes, communities, and specific stands of old-growth, and then only when the treatments are very narrowly targeted to the immediate vicinity of the structures to be protected.

A review of six fires that occurred in the southwestern US in 2000 revealed that they were not necessarily inconsistent with natural patterns as originally thought.

> BAER maps tended to overestimate area of severe burns and underestimate area of moderate-severity burns relative to NBR maps. Low elevation and more southern ponderosa pine burns were predominantly understory burns, whereas burns at higher elevations and farther north had a greater component of high-severity burns. Thus, much, if not most, of the area covered by these burns appears to be consistent with historic burns and contributes to healthy functioning ecosystems.

Natasha B. Kotliar, Sandra L. Haire, and Carl H. Key. Lessons From the Fires of 2000: Post-Fire Heterogeneity in Ponderosa Pine Forests. http://www.fs.fed.us/rm/pubs/rmrs_p029/rmrs_p029_277_280.pdf *in* Omi, Philip N.; Joyce, Linda A., technical editors. 2003. Fire, fuel treatments, and ecological restoration: Conference proceedings; 2002 16-18 April; Fort Collins, CO. Proceedings RMRS-P-29.

The agency's bias is further evidenced by the fact that the NEPA analysis fails to disclose that during extreme weather conditions (hot, dry, and windy) a canopy fire could easily kill the forests areas whether they are treated or not.

If the agency describes the effects of future fire, they must describe at least one scenario involving favorable fire weather: relatively high fuel moisture, relatively low wind speed, relatively low humidity, relatively low air temperature, etc. If the agency describes the effects of extreme fire behavior them must disclose that even the treated stands will likely experience stand replacing fire during extreme fire weather conditions (hot dry, windy). The agency must also disclose that logging will at least temporarily increase some forms of hazardous fuels.

The Healthy Forest Initiative was premised in part on the idea that wild fires are increasing in extent and intensity and rate of spread, but this may not be the case. The extent of fires in the 1920s through 1940s was relatively high compared to recent periods.

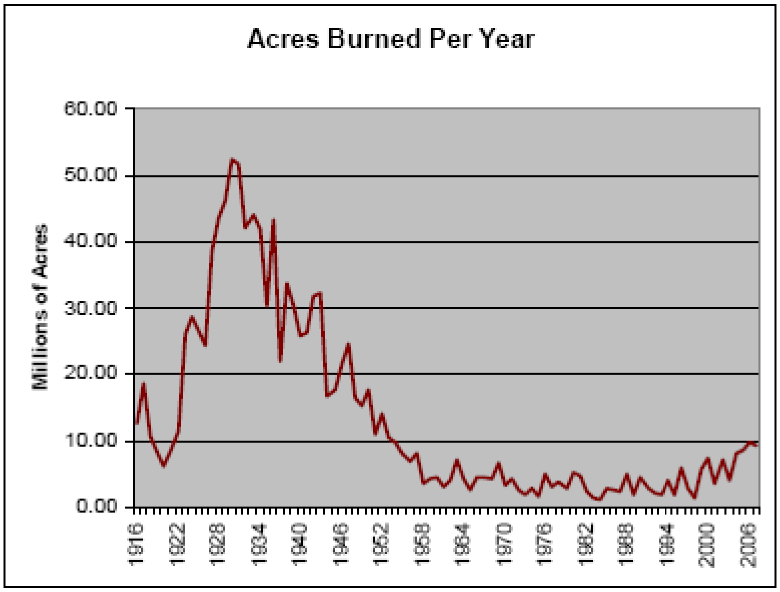
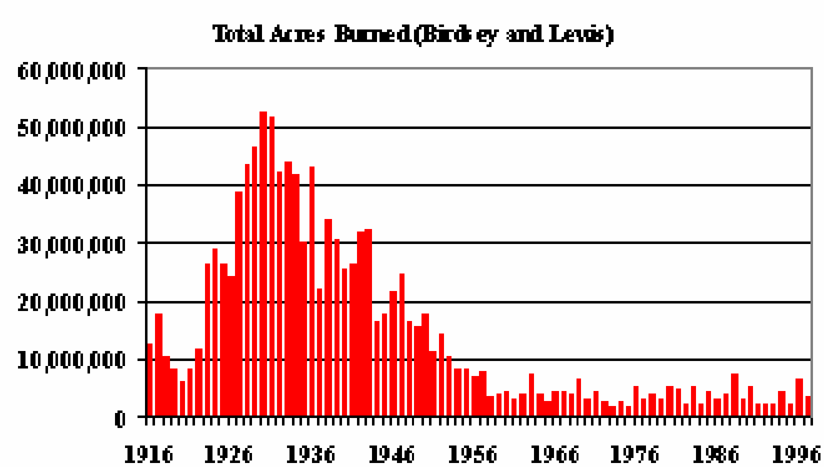


Figure 1. Total Acreage burned

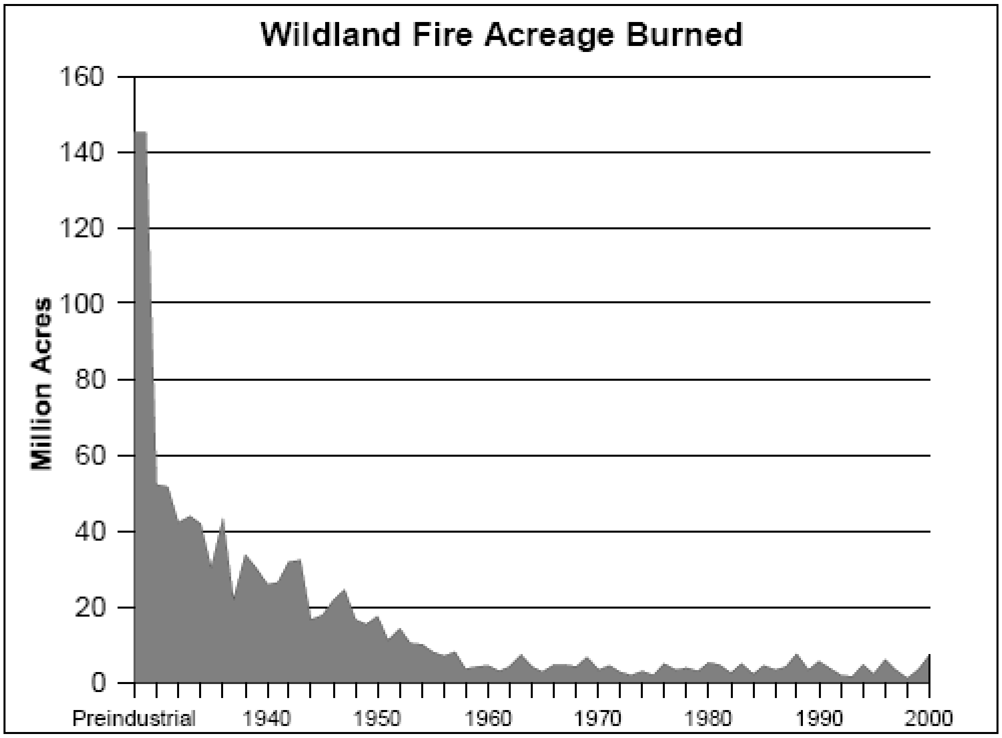
This figure shows forest acreage burned.



Historic Fire Occurrence in Oregon (in thousands of acres)	
1916-1938	177.9
1939-1953	79.6
1954-1963	36.1
1964-1977	64.9
1978-1987	159.6
1988-1997	136.9

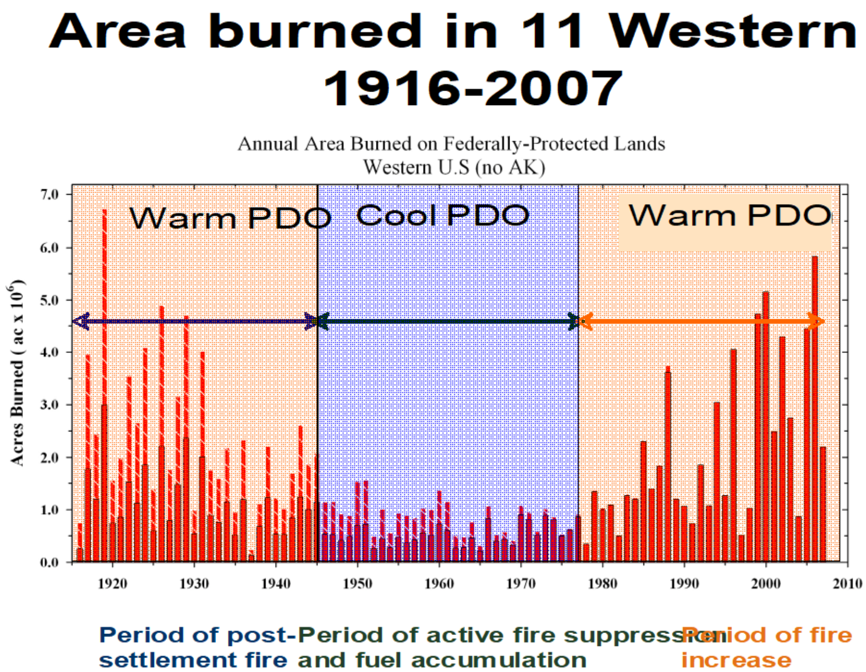
[from Table 18a]

Birdsey, Richard A.; Lewis, George M. 2002. Current and Historical Trends in Use, Management and Disturbance of United States Forest Lands. IN: Kimble, John et al. (eds.), The Potential of U.S. Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect. Boca Raton, Florida: CRC Press. XXX p.
http://www.fs.fed.us/ne/global/pubs/books/fslulc2/chapter02.html.
http://www.fs.fed.us/ne/global/pubs/books/fslulc2/lu_english/table18.html.
http://www.fs.fed.us/ne/global/pubs/books/fslulc2/lu_english/table18a.html.



> "Historically, fire has been a frequent and major ecological factor in North America. In the conterminous United States during the preindustrial period (1500- 1800), an average of 145 million acres burned annually. Today only 14 million acres (federal and non-federal) are burned annually by wildland fire from all ignition sources. Land use changes such as agriculture and urbanization are responsible for 50 percent of this 10-fold decrease. Land management actions including land fragmentation and fire suppression are responsible for the remaining 50 percent. This decrease in wildland fire has been a destabilizing influence in many fire adapted ecosystems ponderosa pine, lodgepole pine, pinyon/juniper woodlands,…"

2001 Review and Update of the 1995 Federal Wildland Fire Management Policy:
http://web.archive.org/web/20090115183448/http://www.nifc.gov/fire_policy/history/index.htm.
http://web.archive.org/web/20030417044422/http://www.nifc.gov/fire_policy/docs/chp1.pdf.
http://www.fusee.org/federal-fire-policy-documents
http://www.fusee.org/federal-fire-policy-reports.



Peterson, Dave 2008. Effects of Climate Change on Western Forests. Conferenece presentation: Climate Change Impacts on Natural Resource Management in the Columbia Basin. June 24, 2008. http://www.fws.gov/pacific/Climatechange/pdf/boise/Peterson/PDF%20of%20Powerpoint/Peterson%20Climate%20change%20and%20forests%20-%20USFWS,%20Boise%20%20(062408).pdf

See also July 2006 SciencExpress Article, Anthony Leroy Westerling, Hugo G. Hidalgo, Daniel R. Cayan, Thomas W. Swetnam. 2006. Warming and Earlier Spring Increases Western U.S. Forest Wildfire Activity. [“Western United States forest wildfire activity is widely thought to have increased in recent decades, but surprisingly, the extent of recent changes has never been systematically documented. Nor has it been established to what degree climate may be driving regional changes in wildfire.”] Mid and high elevation forests like lodgepole pine, spruce, and fir were found to have increased fire risk due to a warming climate, and not due to the structure of the forest.
http://www.sciencemag.org/cgi/content/abstract/1128834v1.
http://web.archive.org/web/20060720180726/http://www.uec-utah.org/wildfire_and_climate.htm.

Do not rely on the flawed boilerplate climate analyses

As explained below, the Forest Service's boilerplate NEPA analysis regarding carbon and climate fails to take a hard look that NEPA requires. The analysis makes several highly misleading statements about forest carbon and climate change. The analysis inappropriately mischaracterizes the role of individual logging projects in the cumulative problem of global GHG emissions. The analysis misstates the effects of logging related carbon emissions that are not related to "deforestation." The analysis grossly misstates the climate effects of logging intended to reduce disturbance. The analysis misleadingly implies that logging benefits the climate by increasing forest productivity.

The NEPA analysis should consider the adverse climate consequences of GHG emissions caused directly and indirectly by logging. The Forest Service should not rely on the boilerplate NEPA language from the regional office which is flawed in many ways. Instead the Forest Service:

- Must recognize the cumulative nature of the GHG emissions and climate problems. It does not matter that this project is small in the global scheme because all emissions matter when the causation is global and cumulative;

- Cannot credibly assert that this project is harmless because it's not causing deforestation. This is immaterial. All GHG emissions, regardless of the source or how it is labelled, are part of the problem and cause the same climate impacts.

- Cannot credibly assert that thinning for forest health justifies or mitigates emissions from logging. Logging does not increase the capacity for growing trees. To the contrary, logging harms soil and reduces site productivity.

- Must not compare carbon *before and after* logging. That is an improper framework for NEPA analysis. The proper NEPA framework is to compare the effects of NEPA alternatives over time, so please describe the carbon emissions and carbon storage in the forest over time *with and without* logging.

- Logging to reduce fire effects does not result in a net increase in forest carbon storage. The agency cannot predict the location, timing, or severity of future wildfires, so most fuel treatments will cause carbon emissions without any offsetting benefits from modified fire behavior. Studies clearly show that the total carbon emissions from logging (plus unavoidable wildfire) are greater than carbon emissions from fire alone.

- Cannot credibly assert that carbon storage in wood products is a useful climate strategy. Logging kills trees, stops photosynthesis, and initiates decay and combustion, with the end result being a significant transfer of carbon from the forest to the atmosphere. In stark contrast, an unlogged forest continues to grow and transfer more carbon from the atmosphere to the forest. Carbon emissions caused by logging far exceed the small fraction of carbon transferred to wood products. Carbon accounting methods that attempt to account for *substitution* of wood for other high-carbon building materials are fraught

> with uncertainty and too often represent maximum potential substitution effects rather than lower realistic estimates.

Cumulative Impacts of GHG Emissions Must not be Minimized

The NEPA analysis must avoid minimizing this project's contribution to carbon emissions and global warming by saying the effects of this project would be negligible on a global scale. This is not an appropriate framework. Global climate change and ocean acidification are the result of the **cumulative** effects on the **global** carbon cycle which is spatially distributed. There is no single culprit, nor is there a silver bullet solution. All emissions are part of the problem, and all land management decisions must be part of the solution. Since the global carbon cycle is spatially distributed, carbon storage and carbon emissions will always we spread out around the globe, and the carbon flux at any given place and time may appear small, but *cumulatively* they help determine the temperature of our climate and the pH of our oceans. Given the current carbon overload in the atmosphere and oceans, the carbon consequences of every project must be carefully considered (rather than dismissed as negligible).

The agency may argue that logging a few small patches of forest won't make a difference in the global scheme of the climate problem, but as Voltaire said, "No snowflake in an avalanche ever feels responsible." The NEPA analysis must recognize that global warming will not be solved by one miraculous technological fix or by changing one behavior or one economic activity. The whole global carbon cycle must be managed to reduce carbon emissions and increase carbon uptake. Recent evidence supports the conclusions that all net emissions of greenhouse gases are adverse to the climate. None can be considered *de minimus*. "We show first that a single pulse of carbon released into the atmosphere increases globally averaged surface temperature by an amount that remains approximately constant for several centuries, even in the absence of additional emissions. We then show that to hold climate constant at a given global temperature requires near- zero future carbon emissions. Our results suggest that future anthropogenic emissions would need to be eliminated in order to stabilize global-mean temperatures. As a consequence, any future anthropogenic emissions will commit the climate system to warming that is essentially irreversible on centennial timescales." H. Damon Matthews and Ken Caldeira. 2009. Stabilizing climate requires near-zero emissions. Nature Vol 455 | 18 September 2008 | doi:10.1038/nature07296.

Former D.C. Circuit Judge Wald wrote in a 1990 dissenting opinion, which was recently quoted with unanimous approval by the Ninth Circuit in Center *for Biological Diversity v. NHTSA*:

> [W]e cannot afford to ignore even modest contributions to global warming. If global warming is the result of the cumulative contributions of myriad sources, any one modest in itself, is there not a danger of losing the forest by closing our eyes to the felling of the individual trees?

538 F.3d at 1217. Similarly, the U.S. Supreme Court's decision in *Massachusetts v. EPA* noted that one cannot avoid responsibility to reduce and mitigate the climate problem by attempting to

minimize the scale of one's contribution to the problem. ("While it may be true that regulating motor-vehicle emissions will not by itself reverse global warming, it by no means follows that we lack jurisdiction to decide whether EPA has a duty to take steps to slow or reduce it.... In sum, … [t]he risk of catastrophic harm, though remote, is nevertheless real. That risk would be reduced to some extent if petitioners received the relief they seek." 127 S.Ct. 1438, 1455 (2007) http://web.archive.org/web/20080610172128/http://www.supremecourtus.gov/opinions/06pdf/05-1120.pdf)

The responsibility to reduce emissions no matter how small is recognized in international law such as the European Convention on Human Rights.

> The fact that the amount of the Dutch emissions is small compared to other countries does not affect the obligation to take precautionary measures in view of the State's obligation to exercise care. After all, it has been established that any anthropogenic greenhouse gas emission, no matter how minor, contributes to an increase of CO2 levels in the atmosphere and therefore to hazardous climate change.

Urgenda Foundation v. The State of the Netherlands. Hague Court of Appeal. October 9, 2018. https://uitspraken.rechtspraak.nl/inziendocument?id=ECLI:NL:RBDHA:2015:7196.

CEQ draft guidance on NEPA and climate change recognizes that disclosure of the incremental nature of GHG emissions attributable to any given project is merely a restatement of the nature of the climate problem itself and NEPA does not allow agencies to avoid disclosure and consideration of alternatives and mitigation.

> CEQ recognizes that many agency NEPA analyses to date have concluded that GHG emissions from an individual agency action will have small, if any climate change effects. Government action occurs incrementally, program-by-program and step-by-step, and climate impacts are not attributable to any single action, but are exacerbated by a series of smaller decisions, including decisions made by the government. Therefore, the statement that emissions from a government action or approval represent only a small fraction of global emissions is more a statement about the nature of the climate change challenge, and is not an appropriate basis for deciding whether to consider climate impacts under NEPA.
>
> Moreover, these comparisons are not an appropriate method for characterizing the potential impacts associated with a proposed action and its alternatives and mitigations. This approach does not reveal anything beyond the nature of the climate change challenge itself: The fact that diverse individual sources of emissions each make relatively small additions to global atmospheric GHG concentrations that collectively have huge impact.

77 Fed. Reg. 77802, 77825. (Dec. 24, 2014).

Agency NEPA analyses often say that the "Literature, however, has not yet defined any specifics on the nature or magnitude of any cause and effect relationship between greenhouse gases and climate change. [and] it is currently beyond the scope of existing science to identify a specific source of greenhouse gas emissions or sequestration and designate it as the cause of specific climate impacts at a specific location." The agency should stop saying this. Such statements are obviously part of the agency's dismissive boilerplate about climate change but they add nothing to the analysis, but they imply that things are far more uncertain than they are, and that logging-related GHG emissions can't be connected to the crime of global climate change, which is nonsense. What we know is that climate change is caused by cumulative effects. All GHG emissions become globally distributed in our well-mixed atmosphere, so all emissions are related to all harms and effects of global climate change. These effects are set forth in great detail in the scientific literature and IPCC reports. So, GHG emissions are bad and CO2 uptake by forests is good, and the agency's logging program increases GHG emissions and reduces CO2 uptake.

Because individual contributions to climate change are so small, but the cumulative problem is so large, meaningfully disclosing the impact of greenhouse gas emissions requires some tool beyond merely identifying physical changes in the environment attributable to an individual project's emissions.

Climate change is the quintessential cumulative impact problem, and a good way to disclose the incremental effects of individual contributions to the cumulative problems is to monetize the effects using tools that quantify the social cost of carbon dioxide emissions. Social Cost of Carbon 2010, https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/foragencies/Social-Cost-of-Carbon-for-RIA.pdf.

Individual physical changes that will result from any particular action will inevitably appear insignificant. Just as the public and decisionmakers "cannot be expected to convert curies or mrems into such costs as cancer deaths," the EIS's readership cannot be expected to understand whether an individual project's miniscule marginal increase contribution to increased temperature, sea levels, etc. is cause for concern. *Natural Res. Def. Council, Inc. v. U. S. Nuclear Regulatory Comm'n*, 685 F.2d 459, 487 n.149 (D.C. Cir. 1982) rev'd on other grounds sub nom. *Baltimore Gas & Elec. Co. v. Natural Res. Def. Council, Inc.*, 462 U.S. 87, 106-107 (1983).

Estimates of the social cost of carbon dioxide emissions are based on reasonable forecasts of the actual physical effects that each incremental unit of greenhouse gas emissions will have on the environment, including temperature, sea level rise, ecosystem services, and other physical impacts, together with assessments of how these physical changes will impact agriculture, human health, etc. The social cost protocol identifies the social cost imposed by a ton of emissions' pro rata contribution to these environmental problems. This either amounts to an assessment of physical impacts or the best available generally accepted alternative to such an assessment; either way, the tool is appropriate for use under NEPA. 40 C.F.R. § 1502.22(b)(4).

Any assertion that it is impossible to discuss the impact or significance of the Project's greenhouse gas emissions is arbitrary. Agencies must use available generally accepted tools to address the impact of these emissions, 40 C.F.R. 1502.22, and employ reasonable forecasting in its analysis. The agency's refusal to use available modeling tools, such as the estimates of the social cost of carbon and other greenhouse gases, violates NEPA.

Risk reduction logging does not help store carbon.

Forest Service NEPA analyses often include the following assertion - "The release of carbon associated with this project is justified given the overall change in condition increases forest resistance to release of much greater quantities of carbon from wildfire, drought, insects/disease, or a combination of these disturbance types (Millar 2007)" This is inaccurate and misleading.

Logging proponents often claim that logging will increase carbon storage controlling carbon emissions caused by natural processes such as fire and insect-induced mortality.
This is simply counter-factual. In most cases, managing forests in an effort to control natural processes that release carbon will only make things worse by releasing MORE carbon. This is mostly because no one can predict where fire or insects will occur, so the treatments must be applied to broad landscapes, yet the probability of fire or insects at any given location remains low, and only a small fraction of the treated areas will actually experience fire or insects. As a result, many acres will be treated "unnecessarily" and therefore the cumulative carbon emissions from logging to control fire and insects (plus the carbon emissions from fire and insects that occur in spite of control efforts) are greater than emissions from fire and insects alone. A careful analysis shows that logging to control fire and expecting to increase carbon storage is analogous to rolling a die and expecting to roll a six every time.

This is an example of the "base rate fallacy" or "neglecting priors" from Bayesian statistics. The probability of a forest stand NOT burning are far greater than the probability of a forest stand burning. Attempts to address a problem that is unlikely to occur, such as by thinning a forest that is unlikely to burn, runs a high risk that unintended negatives effects will overwhelm beneficial effects. https://en.wikipedia.org/wiki/Base_rate_fallacy

The 2018 US Forest Service Northwest Forest Plan Science Synthesis concluded that fuel reduction is unlikely to be an effective climate mitigation strategy.

> Some studies from other regions in the Western United States (i.e., the Southwest and Sierra Nevada) suggest that thinning and fuel reduction can mitigate carbon loss from fire. Fuel reduction may reduce losses of carbon at stand levels compared with the consequences of high-severity wildfire burning in stands with high fuel loads (Finkral

and Evans 2008; Hurteau and North 2009; Hurteau et al. 2008, 2011, 2016; North and Hurteau 2011; North et al. 2009, Stephens et al. 2009). However, because the probability of treated areas burning is generally low (Barnett et al. 2016), and most biomass is not consumed by fire, slight differences in losses resulting from combustion in fire compared with losses from fuel reduction are unlikely to make fuel reduction a viable mitigation strategy (Ager et al. 2010, Campbell et al. 2012, Kline et al. 2016, Mitchell et al. 2009, Restaino and Peterson 2013, Spies et al. 2017).

USDA 2018. Synthesis of Science to Inform Land Management Within the Northwest Forest Plan Area. General Technical Report. PNW-GTR-966 Vol. 1. June 2018. https://www.fs.fed.us/pnw/pubs/pnw_gtr966_vol1.pdf.

Law & Harmon (2011) conducted a literature review and concluded …

> Thinning forests to reduce potential carbon losses due to wildfire is in direct conflict with carbon sequestration goals, and, if implemented, would result in a net emission of CO2 to the atmosphere because the amount of carbon removed to change fire behavior is often far larger than that saved by changing fire behavior, and more area has to be harvested than will ultimately burn over the period of effectiveness of the thinning treatment.

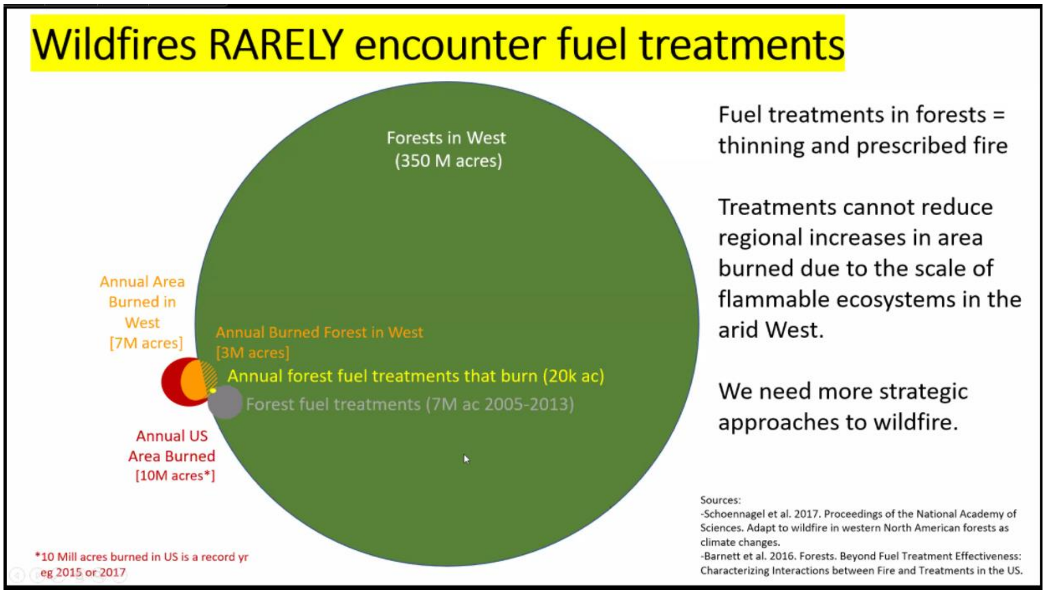
Law, B. & M.E. Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1). https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf.

Campbell and Agar (2013) conducted a sensitivity analysis and found robust results indicating that fuel reduction does not increase forest carbon storage.

> … we attempt to remove some of the confusion surrounding this subject by performing a sensitivity analysis wherein long-term, landscape-wide carbon stocks are simulated under a wide range of treatment efficacy, treatment lifespan, fire impacts, forest recovery rates, forest decay rates, and the longevity of wood products. Our results indicate a surprising insensitivity of long-term carbon stocks to both management and biological variables. After 80 years, … a 1600% change in either treatment application rate or efficacy in arresting fire spread resulted in only a 10% change in total system carbon. This insensitivity of long-term carbon stocks is due in part by the infrequency of treatment/wildfire interaction and in part by the controls imposed by maximum forest biomass. None of the fuel treatment simulation scenarios resulted in increased system carbon.

Campbell, J, Agar, A (2013) Forest wildfire, fuel reduction treatments, and landscape carbon stocks: A sensitivity analysis. Journal of Environmental Management 121 (2013) 124-132 http://fes.forestry.oregonstate.edu/sites/fes.forestry.oregonstate.edu/files/PDFs/Campbell_2013_JEM.pdf

This graph shows that logging for fuel reduction rarely interacts with wildfire, which explains why the carbon emissions from widespread fuel reduction logging vastly exceeds the carbon emissions avoided in the rare cases where fuel reduction does interact favorably with wildfire.



There are now webtools available that can help the agencies deal with uncertainty surrounding the efficacy of fuel reduction. For instance, this web-based spreadsheet (http://getguesstimate.com/) allows users to create models with confidence intervals around input variables. Then it runs thousands of Monte Carlo simulations to come up with estimates of model behavior. The agencies could use this to better estimate the improbability that fuel treatments would interact with fire and estimate the improbable carbon benefits of fuel reduction logging.

Before attributing carbon benefits to fuel reduction logging please consider the conclusions of:

- John L Campbell, Mark E Harmon, and Stephen R Mitchell. 2011. Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions? Front Ecol Environ 2011; doi:10.1890/110057 http://forestpolicypub.com/wp-content/uploads/2011/12/campbell-2011.pdf. (Results suggest that the protection of one unit of C from wildfire combustion comes at the cost of removing three units of C in fuel treatments.)
- Mitchell, Harmon, O'Connell. 2009. Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems. Ecological Applications. 19(3), 2009, pp. 643–655. http://www.fs.fed.us/pnw/pubs/journals/pnw_2009_mitchell001.pdf. ("…reducing the fraction by which C is lost in a wildfire requires the removal of a much greater amount of C, since most of the C stored in forest biomass (stem wood, branches, coarse woody debris) remains unconsumed even by high-severity wildfires. For this reason, all of the fuel reduction treatments simulated for the west Cascades and Coast Range ecosystems as well as most of the treatments simulated for the east Cascades resulted in a

reduced mean stand C storage…. We suggest that forest management plans aimed solely at ameliorating increases in atmospheric CO2 should forego fuel reduction treatments …")

- Reinhardt, Elizabeth, and Lisa Holsinger 2010. Effects of fuel treatments on carbon-disturbance relationships in forests of the northern Rocky Mountains. Forest Ecology and Management 259 (2010) 1427–1435. http://www.fs.fed.us/rm/pubs_other/rmrs_2010_reinhardt_e002.pdf ("Although wildfire emissions were reduced by fuel treatment, the fuel treatments themselves produced [carbon] emissions, and the untreated stands stored more carbon than the treated stands even after wildfire. … Our results show generally long recovery times …")
- Law, B. & M.E. Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1). https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf ("Thinning forests to reduce potential carbon losses due to wildfire is in direct conflict with carbon sequestration goals, and, if implemented, would result in a net emission of CO2 to the atmosphere because the amount of carbon removed to change fire behavior is often far larger than that saved by changing fire behavior, and more area has to be harvested than will ultimately burn over the period of effectiveness of the thinning treatment.")
- Restaino, Joseph C.; Peterson, David L. 2013. Wildfire and fuel treatment effects on forest carbon dynamics in the western United States. Forest Ecology and Management 303:46-60. http://www.fs.fed.us/pnw/pubs/journals/pnw_2013_restiano001.pdf ("… C costs associated with fuel treatments have can exceed the magnitude of C reduction in wildfire emissions, because a large percentage of biomass stored in forests (i.e., stem wood, branches, coarse woody debris) remains unconsumed, even in high-severity fires (Campbell et al., 2007; Mitchell et al., 2009). … Wildfire occurrence in a given area is uncertain and may never interact with treated stands with reduced fire hazard, ostensibly negating expected C benefits from fuel treatments. Burn probabilities in treated stands in southern Oregon are less than 2%, so the probability that a treated stand encounters wildfire and creates C benefits is low (Ager et al., 2010).)"
- Goslee, K., Pearson, T., Grimland, S., Petrova, S., Walls, J., Brown, S., 2010. Final Report on WESTCARB Fuels Management Pilot Activities in Lake County, Oregon. California Energy Commission, PIER. DOE Contract No.: DE-FC26-05NT42593. http://uc-ciee.org/downloads/Fuels_Management_LakeCo.pdf; AND Pearson, T.R.H., Goslee, K., Brown, S., 2010. Emissions and Potential Emission Reductions from Hazardous Fuel Treatments in the WESTCARB Region. California Energy Commission, PIER. CEC-500-2014-046. http://www.energy.ca.gov/2014publications/CEC-500-2014-046/CEC-500-2014-046-AP.pdf. (Summarized by Restaino & Peterson (2013) as follows: "Pearson et al. (2010) and Goslee et al. (2010) developed methodologies to evaluate C dynamics associated with fuel treatment projects in low to mid-elevation forest in northern California and Oregon. The authors, with consultation from teams of scientists, quantify C storage and release within the context of a six-point conceptual framework: annual fire risk, treatment emissions, fire emissions, forest growth and re-growth, re-treatment, and the shadow effect (i.e., treatment effect outside the treated area). Results indicate that the mean annual probability of wildfire for the study region is less than 0.76%/year, and treatments reduce C stocks by an average of 19%. Where timber is removed, 30% of extracted biomass is stored in long-lasting wood

products. Wildfire emissions in treated stands, quantified with the Fuel Characteristic Classification System, are reduced by 6% relative to untreated stands. Growth estimates for a 60-year simulation horizon, derived from FVS, indicate that in the absence of wildfire, untreated stands sequester 17% more C than treated stands. However, in simulations that include wildfire, treated stands sequester 63% more C than untreated stands. The shadow effect is unlikely to be large enough to affect net GHG emissions. In summary, initial reductions in C stocks (e.g., thinning), combined with low annual probability of wildfire, preclude C benefits associated with fuel treatments, even if harvest residues are used for biomass energy.")

- Chiono, Lindsay 2011. Balancing the Carbon Costs and Benefits of Fuels Management. Research Synthesis for Resource Managers. Joint Fire Science Program Knowledge Exchange. http://static1.squarespace.com/static/545a90ede4b026480c02c5c7/t/5527ebd9e4b0f620d0cb5b58/1428679641640/CFSC_Chiono_Carbon_and_Fuel_Mngmt.pdf ("[T]he net carbon impact of fuel treatments is further complicated by the probabilistic nature of wildfire occurrence and the impermanence of post-treatment stand conditions … [T]reatment activities produce an immediate carbon emission while future wildfire emissions are uncertain … Depending on the intensity of treatment, the quantity of carbon removed may be substantial enough to negate gains from avoided wildfire emissions. … cumulative emissions from fuels reduction activities repeated in order to maintain low hazard conditions over time can overwhelm avoided wildfire emissions, resulting in a net carbon loss.")
- Dina Fine Maron 2010. FORESTS: Researchers find carbon offsets aren't justified for removing understory (E&E Report 08/19/2010, reporting on the WESTCARB Project) https://pacificforest.org/pft-in-the-media-2010-climatewire-8-19-10.html. ("'The take-home message is we could not find a greenhouse gas benefit from treating forests to reduce the risk of fire,' said John Kadyszewski, the principal investigator for the terrestrial sequestration projects of the West Coast Regional Carbon Sequestration Partnership. WESTCARB, ... Since there is a relatively low risk of fire at any one site, large areas need to be treated -- which release their own emissions in the treatment process. The researchers have concluded that the expected emissions from treatments to reduce fire risk exceed the projected emissions benefits of treatment for individual projects.")
- Rachel A. Loehman, Elizabeth Reinhardt, Karin L. Riley 2014. Wildland fire emissions, carbon, and climate: Seeing the forest and the trees – A cross-scale assessment of wildfire and carbon dynamics in fire-prone, forested ecosystems. Forest Ecology and Management 317 (2014) 9–19. http://www.fs.fed.us/rm/pubs_other/rmrs_2014_loehman_r001.pdf ("… management of carbon in fire-prone and fire-adapted forests is more complex than simply minimizing wildfire carbon emissions and maximizing stored carbon in individual stands. The stochastic and variable nature of fires, the relatively fine scale over which fuels treatments are implemented, and potentially high carbon costs to implement them suggest that fuel treatments are not an effective method for protecting carbon stocks at a stand level (Reinhardt et al., 2008; Reinhardt and Holsinger, 2010).")
- Jim Cathcart, Alan A. Ager, Andrew McMahan, Mark Finney, and Brian Watt 2009. Carbon Benefits from Fuel Treatments. USDA Forest Service Proceedings RMRS-P-61. 2010.
- Chiono, L. A., D. L. Fry, B. M. Collins, A. H. Chatfield, and S. L. Stephens. 2017. Landscape-scale fuel treatment and wildfire impacts on carbon stocks and fire hazard in California spotted owl habitat. Ecosphere 8(1):e01648. 10.1002/ecs2.1648.

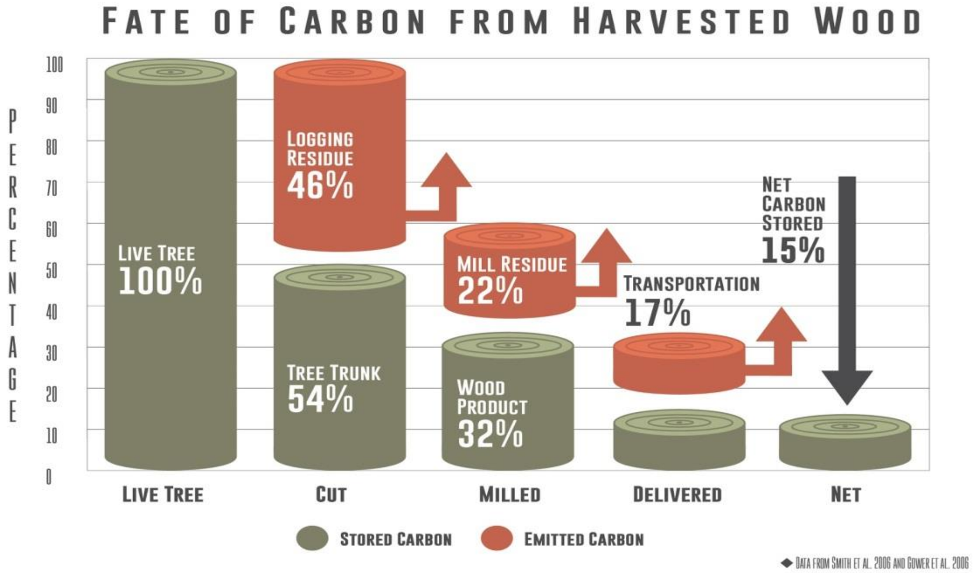
http://onlinelibrary.wiley.com/doi/10.1002/ecs2.1648/full ("We used a probabilistic framework of wildfire occurrence to (1) estimate the potential for fuel treatments to reduce fire risk and hazard across the landscape and within protected California spotted owl (Strix occidentalis occidentalis) habitat and (2) evaluate the consequences of treatments with respect to terrestrial C stocks and burning emissions. Silvicultural and prescribed fire treatments were simulated on 20% of a northern Sierra Nevada landscape in three treatment scenarios … [A]ll treatment scenarios resulted in higher C emissions than the no-treatment scenarios.")

The Carbon Value of Wood Products is Over-estimated.
Forest Service NEPA analyses often state "Utilizing trees to create long-lived wood products sequesters carbon (IPCC 2007) (FAO 2007) (Stavins 2005) (Upton 2007). Some have shown that using wood to build houses has a more favorable carbon balance when compared to other building materials such as steel, concrete or plastic (Wilson 2006)." This is inaccurate and misleading.

Wood products represent net carbon emissions, NOT carbon sequestration, because only a small fraction of the carbon in a logged forest ends up in wood products. Logging causes the majority of forest carbon to be transferred to the atmosphere, not wood products. Science clearly shows that carbon is more safely stored in forests, not wood products.

Some argue that wood products are a good place to store carbon. This is a counter-productive climate strategy, because –

Only a small fraction of carbon from logged forests ends up in long-term storage in wood products, most is transferred to the atmosphere. Of all the carbon that is killed and/or exposed to accelerated decay in a logging operation only a small fraction ends up as durable goods and buildings -- most ends up as slash, sawdust, waste/trim, hog fuel, and non-durable goods like paper. Some say that converting forest to wood products "delays" emissions, but in fact logging accelerates emissions because they are the result of a process that kills trees that would continue to actively sequester carbon if not logged, and logging involves tremendous waste in the logging process, milling process, construction/manufacturing process.



Carbon remains stored much longer in forests than in wood products. Much of the wood products which can reasonably be considered "durable" are in fact less durable than leaving the carbon stored safely inside a mature tree that might live to be hundreds of years old. Most of our wood products are disposable. It turns out that well-conserved forests on average store carbon more securely than our "throw-away" culture and economy does. Law, B. & M.E. Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1). https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf ("To the extent that management can direct carbon into longer lived pools, it can increase the stores of carbon in the forest sector. Harvest of carbon is one proposed strategy to increase carbon stores. However, harvesting carbon will increase the losses from the forest itself and to increase the overall forest sector carbon store, the lifespan of wood products carbon (including manufacturing losses) would have to exceed that of the forest. Under current practices this is unlikely to be the case. A substantial fraction (25–65%) of harvested carbon is lost to the atmosphere during manufacturing and construction depending on the product type and manufacturing method. The average lifespan of wood buildings is 80 years in the USA, which is determined as the time at which half the wood is no longer in use and either decomposes, burns or, to a lesser extent, is recycled. However, many forest trees have the potential to live hundreds of years (e.g. 800 years in the Pacific northwest USA). Mortality rates of trees are generally low, averaging less than 2% of live mass per year in mature and old forests; for example, in Oregon, mortality rates average 0.35–1.25% in forests that are older than 200 years in the Coast Range and Blue Mountains, respectively [8]. Moreover, the average longevity of dead wood and soil carbon is comparable to that of live trees. When the loss of carbon associated with wood products manufacturing is factored in, it is highly unlikely that harvesting carbon and placing it into wood products will increase carbon stores in the overall forest sector.

This explains why in all analyses conducted to date, wood products stores never form the majority of total forest sector stores.")

Reliance on wood products prevents forests from reaching their potential for carbon storage. Shanks (2008) said "There are also losses of carbon that occur during the creation of forest products. These losses to decay and wood products make carbon sequestration slower when harvesting is allowed. The young timberlands that replace older harvested lands grow quickly, but hold less in total carbon stores than their older counterparts; the net sequestration from forest products adds to total carbon stores, but does not come close to the vast amounts of carbon stored in non-harvested older timberlands. This finding differs from other papers that have shown that the highest carbon mitigation can be reached when high productivity lands are used exclusively for wood products creation (Marland and Marland, 1992). The wood products considered in these studies were either long lasting or used for fuel purposes. Allowing harvested timber to be allocated to all types of wood products increases carbon emissions and results in no harvest regimes sequestering more carbon." Alyssa V. Shanks. 2008. Carbon Flux Patterns on U.S. Public Timberlands Under Alternative Timber Harvest Policies. MS Thesis. March 2008. http://ir.library.oregonstate.edu/dspace/bitstream/1957/8326/1/A_Shanks_Thesis_04%2002%2008_final.pdf.

The amount of carbon missing from our forests vastly greater than the amount of carbon that can be accounted for in wood products storage. BLM's WOPR FEIS shows that decades of converting old growth forests to plantations has reduced current forest carbon stores on BLM lands in western Oregon by 149 million tons, while some of that wood was converted into wood products, only 11 million tons of that carbon remains stored in wood products today, so logging our public forests to make wood products results in approximately 13 times more carbon emissions than carbon storage. This is pieced together from WOPR FEIS Figures 3-17 (p 3-221) and Figure 3-18 (p 3-224). Further logging of mature forests will exacerbate this outcome.

A lot of wood products are "stored" in landfills where they emit methane which has a global warming effect much greater than CO2. A. 2009 Wood Products and Carbon Storage: Can Increased Production Help Solve the Climate Crisis? Washington, D.C.: The Wilderness Society. http://web.archive.org/web/20100601080813/http://wilderness.org/files/Wood-Products-and-Carbon-Storage.pdf. ("Key Points - 1. When wood is removed from the forest, most of it is lost during processing. The amount lost varies tremendously by region, tree species and size, and local infrastructure. 2. The majority of long-term off-site wood carbon storage occurs in landfills, where decomposing wood gives off significant amounts of methane, a gas with high global warming potential. 3. In addition to wood processing losses, fossil fuels are required to turn raw logs into finished products and ship them from forest to mill to construction site to landfill. 4. Once wood losses and fossil emissions are accounted for, the process of harvesting wood and turning it into products may release more greenhouse gases than the emissions saved by storing carbon in products and landfills. … 9. Properly managed, wood can be a renewable source of building materials and fuels, but solving the climate crisis will require reducing the use of all materials and energy.")

Living trees, even if they are "suppressed" store and accumulate carbon better than dead wood products. Even a suppressed tree stores carbon better than a dead tree after it is logged, limbed, bucked, debarked, milled, planed, processed, trimmed, manufactured, used, and then discarded. Recent evidence shows that slower-growing older trees tend to channel their energy into structural support and defense compounds to "maximize durability while minimizing … damage". Colbert & Pederson. 2008. Relationship between radial growth rates and lifespan within North American tree species. Ecoscience 15(3), 349-357 (2008). http://fate.nmfs.noaa.gov/documents/Publications/Black_et_al_2008_Ecoscience.pdf. See also, University of Montana. June 18, 2019. Cell structure linked to longevity of slow-growing Ponderosa Pines. https://www.sciencedaily.com/releases/2019/06/190618174358.htm ("Slow-growing ponderosa pines may have a better chance of surviving longer than fast-growing ones, especially as climate change increases the frequency and intensity of drought, according to new research from the University of Montana. ... [A] key difference between fast and slow growers resides in a microscopic valve-like structure between the cells that transport water in the wood, called the pit membrane. The unique shape of this valve in slow-growing trees provides greater safety against drought, but it slows down water transport, limiting growth rate.") *citing* Beth Roskilly, Eric Keeling, Sharon Hood, Arnaud Giuggiola, Anna Sala. Conflicting functional effects of xylem pit structure relate to the growth-longevity trade-off in a conifer species. Proceedings of the National Academy of Sciences, 2019; 201900734 DOI: 10.1073/pnas.1900734116.

The "substitution" value of wood products is vastly over-estimated. The timber industry must not be allowed to continue business-as-usual and call it "climate friendly" because logging mature & old-growth forests on public lands and short-rotation clear-cutting on private lands are NOT climate friendly. Many in the timber industry like to promote logging as a solution to climate change because (they say) building with wood helps off-set construction using alternative materials such as steel and cement that may release more CO_2 during their manufacture. (See e.g., CORRIM analysis, http://www.corrim.org/reports/2005/swst/140.pdf , http://www.masonbruce.com/wfe/2004Program/1B1_Bruce_Lippke.pdf) Others appropriately promote protection of mature and old-growth forests as more reliable ways to store carbon in forests and long-rotation forestry as the most appropriate way to obtain wood products. It's absurd to conclude that we can continue to destroy our forests to save the climate. Life on earth, especially forests, are the bilge pump that keeps our climate boat afloat.

The timber industry vastly over-states the alleged climate benefit of storing carbon in wood products or using wood as a *substitute* for alternative building materials. While wood may be preferable to other materials in some applications and there is a grain of truth in the substitution analysis, the timber industry's efforts to show a "substitution" benefit from short-rotation forestry is severely flawed. Most of the analyses that tout this effect are produced and advocated by the timber industry with unreasonable assumptions that don't stand up to scrutiny. Note that the mission of the CORRIM group is to promote the use of wood products, not to develop sound forest policy or climate policy. The substitution argument is an example of the timber industry carefully choosing assumptions to guarantee a certain result and then stopping the analysis short of a complete picture of the issue.

> Substitution of wood for more fossil carbon intensive building materials has been projected to result in major climate mitigation benefits often exceeding those of the forests themselves. A reexamination of the fundamental assumptions underlying these projections indicates long-term mitigation benefits related to product substitution may have been overestimated 2- to 100-fold. This suggests that while product substitution has limited climate mitigation benefits, to be effective the value and duration of the fossil carbon displacement, the longevity of buildings, and the nature of the forest supplying building materials must be considered. ... Conversion of older, high carbon stores forests to short rotation plantations would over the long term likely lead to more carbon being added to the atmosphere despite some of the harvested carbon being stored and production substitution occurring.

Mark E Harmon 2019. Have product substitution carbon benefits been overestimated? A sensitivity analysis of key assumptions. Environ. Res. Lett. *in press* https://doi.org/10.1088/1748-9326/ab1e95.

Each substantive issue discussed in these comments should be (i) incorporated into the purpose and need for the project, (ii) incorporated into a NEPA alternative, (iii) carefully analyzed as part of the effects analysis, and (iv) considered for mitigation.

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Sincerely,

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